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# THE WORKS

OF THE HONOURABLE

# ROBERT BOYLE.

In SIX VOLUMES.

To which is prefixed

The LIFE of the AUTHOR.

## VOLUME THE SECOND.

A NEW EDITION.

Ex rerum Causis Supremam noscere Causam.
H. Gravelot inv. et delin.

LONDON:
Printed for W. Johnston, S. Crowder, T. Payne, G. Kearsley, J. Robson,
B. White, T. Becket and P. A. De Hondt, T. Davies, T. Cadell,
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M DCC LXXII.

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BRITAN
NICVM

### SOME
# CONSIDERATIONS
### TOUCHING THE
# Uſefulneſs of Experimental Natural PHILOSOPHY.

Propoſed in a familiar DISCOURSE to a FRIEND,
By way of Invitation to the Study of it.

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## *The Publiſher to the Reader.*

IT is, courteous reader, part of the ſatire of *Petronius* againſt the vice of his own time; *Priſcis temporibus, cum adhuc nuda Virtus placeret, vigebant artes ingenuæ, ſummumque certamen inter homines erat, ne quid profuturum ſæculis diu lateret. Democritus omnium herbarum ſuccos expreſſit, & ne lapidum virgultorumque vis lateret, ætatem inter experimenta conſumpſit.* Other examples of the like induſtry he brings, and then concludes againſt the lazineſs and luxury of his own age: *At nos*, ſaith he, *ne paratas quidem artes audemus cognoſcere, ſed accuſatores antiquitatis vitia tantùm docemus & diſcimus.* It was for want of a *Democritus* or two, that he caſts this hard cenſure upon his own time. For notwithſtanding all his harangue in commendation of ſome ages, which were antient to his own, it is evident out of hiſtory, that there was never at once any great number, who ſeriouſly and in earneſt for the benefit of mankind applied themſelves to theſe ſevere ſcrutinies of natural bodies. It is true, that now and then, in all centuries from the beginning of the world, there have appeared ſome perſons of a nature more refined, as if indeed (according to that fancy of the old poets) ſome *Prometheus* had made them either of another metal, or of another temper, from the vulgar, utterly above all mixture with, or embaſement by the common faſhions of this world; who did make it the end of their lives, by ſevering and mixing, making and marring, and multiplying variety of experiments on all bodies, to diſcover their hidden virtues, and ſo to enlarge the power and empire of man. But theſe were ever very few and ſingular. Even in that ſo much celebrated time of *Democritus*, theſe ſtudies were ſo rare, that his uſual exerciſe of the anatomy of beaſts was looked upon as that, which made the ſoundneſs of his mind queſtionable, even as a ſpice of madneſs in him: and probably much more might the vulgar of his age have been amuſed, had they ſeen him torturing minerals and metals in the more toilſome anatomy of fire.

Now if it be a diſhonourable crimination to an age, that it hath brought out no perſons who make it their great endeavour *Ne quid profuturum ſæculis lateat*; and if the diſcovery of one or two perſons of this kind be enough to expiate for, and take off the diſhonour of the proletarian lazineſs and luxury of the reſt; I think I may juſtly eſteem, that the exhibiting to the world the hiſtory of the ſtudies of the honourable author of this piece, may ſerve to be the apology and defence of our age, againſt ſuch cenſures, as that, wherewith the newly cited ſatiriſt ſtained his own time.

And this was one great reaſon, that hath made me very forward to promote the publication of this, and divers other writings of the ſame noble author. For were there only tokens of endeavour in them, the proof of this endeavour (even without attainment) ought to wipe off all imputations of this nature. But this motive, (though I do account, that by exhibiting this expiation I do ſomewhat oblige the age, whoſe honour is thereby defended, yet) was far from being the moſt great and forcible. For the excellence of the works themſelves, even as ſoon as they fell from the pen of the author, did long ſince in all equity ſet an Imprimatur on them:

*Nec ſumunt aut ponunt ſecures*
*Arbitrio popularis auræ.*

*Epicurus*, when he was caſting up the account of his life, upon the very day of his death, mentions a very great pleaſure, that he even then took in two parts of his former ſtudies; and theſe were his *Rationes*, and his *Inventa*; points well argued, and things happily found out. The two very ſame particulars are principally conſpicuous in this enſuing piece. There are good concluſions againſt the enemies of the being and providence of God in the firſt part, and in the ſecond there be notices of divers *Inventa* profitable to the uſe of man. By the one, ſound notions are propoſed to the reader's apprehenſion from the contemplation of God's creation and government of the world, and thereby good matter is ſuggeſted to his affections for the advancement of his devotion: by the other, there are divers things delivered, which may tend to enlarge man's power of doing good: by them, in the whole, both our honour to God, and our charity to our neighbours may be aſſiſted; in which two, the ſubſtantial part of all the moſt noble, not only human, but Chriſtian virtues, both ſpeculative and practical, are certainly contained.

I must not omit, that an argument of this nature, at this time, may juſtly be commended for its ſeaſonableneſs, when divers perſons, who know not the way of experimental philoſophy, and are loth now to give themſelves the trouble of learning it, have been making ſome attempts, very unthankfully, to traduce both it and its promoters.

These conſiderations paſſed with me for reaſons, and had upon me this force and prevalence, that as ſoon as I had the author's leave, I durſt not forbear the committing of them to the preſs, notwithſtanding his many arguments, which were plauſible enough to the contrary; as, namely, that much of the firſt part was written, when he was of ſo immature years, that ſhould I be particular concerning his age then, to any perſon, who hath read the piece, the paucity of ſuch inſtances might juſtly make me deſpair of begetting credit to my relation. Another objection was, that though his method did of neceſſity lead him to it, yet it might be looked upon as unbecoming for him to meddle with the phyſician's art, of which he never did (nor could, by reaſon of his native honour) make any profeſſion. But theſe oppoſitions being raiſed upon points of curioſity in ceremony and outward decorum, were of little weight, when the fore-mentioned noble offices of charity and doing good were in the other ſcale.

The greater queſtion was; Suppoſe them to be publiſhed, but why now? why ſo ſoon? ſhould not rather the edition have been delayed, until it might have come out together with the ſecond ſection of the ſecond part? (which diſcovers the uſe, that may be made of experimental learning, to advance the empire of man over other creatures) or until the common preface, and ſome other little tracts, all written long ſince, and intended to accompany this, might be reviſed by the author; or at leaſt until the author might have had leiſure to have made ſome more new and full animadverſions to the receipts and proceſſes contained in the appendix? The conſideration, which anſwered this objection, was, that this piece, as now printed alone, would make (as you ſee it doth)

doth) a very competent book, which would have by itſelf the perfection, if not of the whole, yet of a more principal part; and of that part, which to profeſſors or candidates of learning is moſt deſireable. And then the author's avocations and other ſtudies being ſo many, that we could prefix no certain time for the complement of the mentioned remaining parts, I was loth to hazard the preſervation of theſe, by deferring the impreſſion; ſince I know there is no ſecurity of the continuance of thoſe writings, which are repoſed only in ſingle, or at moſt in few written copies. I remember, the author had once loſt for a good while one of theſe very eſſays, which are now here printed, and put beyond that danger for the future. Beſides other caſual accidents, the very contingency of human life, and the chance of a man's papers after death, (for to them the queſtion of king *Solomon* is moſt proper and pertinent, *Who knows, whether then they may happen to fall into the hands of a wiſe man or a fool?)* were of force enough to perſuade me to ſecure theſe, when it was in my power, unto the common uſe. Would not printing, in all probability, have preſerved unto us that univerſal hiſtory of vegetables from the cedar of *Lebanus*, unto the moſs, that groweth upon the wall, written by that wiſe and learned king, and the loſs of which we now in vain lament? Would not printing have ſaved that excellent book of *Democritus*, which he inſcribed his ΧΕΙΡΟ΄ΚΜΗΤΑ, or experiments of his own perſonal trial; ſo utterly loſt, that the name of the piece is not mentioned among the catalogue of his writings in *Laertius?* And may not the printing of this piece be a means of the preſervation (beſides the notional part) of divers very uſeful ΧΕΙΡΟ΄ΚΜΗΤΑ of the honourable author? who hath been ever unwearied in the trial of all probable experiments, that may increaſe the light, or advance the profit of mankind, and whom I may now name to be that moſt learned and noble perſon Mr. *Boyle:* for the ceaſing of certain conſiderations, that before made him willing to have his name ſuppreſt, and the general very good acceptance of this diſcourſe, have extorted from his honour, that he no longer conceal himſelf to be the author.

But before I leave the reader, I muſt give him this ſingle advertiſement, that the paſſages included within the paratheſes or crochets, as the preſs ſtyles them, that is, between any two ſuch marks as theſe [ ] were inſerted long ſince the writing of theſe eſſays, upon the relection of ſome parts of the book before he ſent it to me: which I therefore did ſo diſtinguiſh, and do intimate, that there may appear no inconſiſtency in our author, and the reader may not marvel to find ſome things very recent in a book written ſeveral years ago. Farewell.

*RO. SHARROCK.*

## *The Author's Advertiſement about the following Eſſays.*

THAT the title of the following treatiſe might not raiſe in the reader an expectation of more than he will find in the book, I think myſelf obliged to inform him, that, though it come not forth before, divers parts were ſent to the preſs in 1660, or 1661, and this preſent year 1663; yet the very laſt eſſay of it was written divers years before: ſince when thoſe papers were left, ſometimes in the hands of friends, and ſometimes in diſtant places, where I could not come at them: which I mention, that the reader may neither wonder nor blame me, if he now meet with ſome things in them, that have already been publiſhed by others, or are more vulgarly known, than my way of mentioning them implies. For it may, this notwithſtanding, very well be, that when I writ them, no body had yet lighted on ſome of them, and that others of them did then but begin to be taken notice of. And as for the five firſt eſſays, which treat of the uſefulneſs of natural philoſophy to the mind of man, though by my addreſſing them all the way to the gentleman I call *Pyrophilus*, they may ſeem to have been originally written to the ſame perſon, and about the ſame time with the eſſays, that make up the ſecond part; yet indeed a great portion of the firſt part was written, as I remember, 10 or 12 years ago, (when I was ſcarce above 21 or 22 years old) to another friend, to whom the conſiderations, that ſerved to confirm piety, and excite devotion, were far more acceptable than thoſe, that were more purely phyſiological. So that having, whether through lazineſs, or want of leiſure, contented myſelf to ſubſtitute the name of *Pyrophilus* for that of my other friend (who was not unwilling I ſhould do ſo) in a diſcourſe written, when I was ſo young, I would not have the reader think, that I do now ſo approve of all thoſe youthful diſcourſes (which I therefore ſuffer to paſs abroad without a name) as to think all the tenets they propoſed to be irrefragable truths, or all the reaſonings they contain, to be demonſtrative; and that I would at preſent have my judgment eſtimated according to their cogency. But yet I do, without much reluctancy, comply with thoſe friends, who would by no means conſent, that the five firſt eſſays of this treatiſe ſhould not come forth with the reſt; partly becauſe not writing all things for all readers, I hold it not unfit to publiſh ſomething to gratify thoſe, who deſire with me, to be both excited and aſſiſted to admire and praiſe the great and wiſe Author of all things; partly becauſe the treatiſe would ſeem maimed and incompleat, if the latter eſſays ſhould come abroad without the reſt; and partly too, becauſe learned men have been pleaſed to aſſure me, that thoſe eſſays are not deſtitute of notions and ratiocinations, that are not altogether vulgar or contemptible. However thoſe readers, that either cannot reliſh, or at leaſt deſire not any thing, but what is merely phyſiological, may, thus advertiſed, paſs by the former part of this treatiſe, and content themſelves to read over the latter; though they, who ſhall take the pains to read both, will not, perhaps, think their labour loſt; ſince I have taken care to leave even the former part as little diſfurniſhed with experiments and uſeful notions, as, the argument conſidered, I conveniently could. And ſince alſo, for the paucity of ſuch things in the firſt part, I have endeavoured to make amends in the ſecond, which is almoſt wholly phyſiological; concerning which, nevertheleſs, I ſhall admoniſh the reader: and indeed the whole tenets, that make up the following book, are by no means to be looked upon as publiſhed for an accurate treatiſe of the uſefulneſs of true phyſiology, but as familiar writings, that want only the formality of *ſalve* and *vale* to paſs for phyſiological and medical epiſtles; conſiſting of ſuch looſe obſervations, as I thought might be this way preſerved, and did not ſo properly belong to my other writings, as they ſeemed fitted for the uſe, and whereto I have applied them; namely, that being drawn up together into one treatiſe, their union might enable them to make the greater impreſſion, and might (ſomewhat at leaſt) recommend that ſort of learning to a beginner. And one thing, that muſt be eſpecially comprehended in this admonition, is, that the particulars I have mentioned, to ſhew of what uſe chymical experiments may be to a phyſician, are not, poſſibly, the chiefeſt, that even I could ſet down, if I were not reſtrained by ſome juſtifiable conſiderations; eſpecially till I ſee what entertainment the things I now adventure abroad, will meet with there: ſome of thoſe, I reſerve, appearing ſuch to me, that I confeſs, I do not ſlight them enough to be fond of obtruding them upon the publick, if I thought they would not be welcome to it. And I do ſo little deſire to have, what I have written, looked upon as the moſt that can be ſaid, to ſhew the uſefulneſs of experimental philoſophy, that I ſcruple not to acknowledge, there are things, which incline me to ſuſpect, that ſome in the world, though not particularly known to me, may have arcana, to which moſt of the proceſſes I reſerve, as well as all, that is commonly known in chymiſtry, may prove little more than trifles.

# OF THE USEFULNESS OF NATURAL PHILOSOPHY.

## PART I.

## Of its Uſefulneſs in reference to the Mind of Man.

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## ESSAY I.

### *Of the Uſefulneſs of* EXPERIMENTAL PHILOSOPHY, *principally as it relates to the Mind of Man.*

The reaſon why the author endeavours to poſſeſs *Pyrophilus* with the true value of experimental philoſophy.

THE natural philoſophy, wont to be taught in ſchools, being little other than a ſyſtem of the opinions of *Ariſtotle*, and ſome few other writers, is not, I confeſs, *Pyrophilus*, very difficult to be learned; as being attainable by the peruſal of a few of the more current authors. But, *Pyrophilus*, that experimental philoſophy, which you will find treated of in the following Eſſays, is a ſtudy, if duly proſecuted, ſo difficult, ſo chargeable, and ſo toilſome, that I think it requiſite, before I propoſe any particular ſubjects to your inquiries, to poſſeſs you with a juſt value of true and ſolid phyſiology; and to convince you, that by endeavouring to addict you to it, I invite you not to miſpend your time or trouble on a ſcience unable to merit and requite it. In order, *Pyrophilus*, to the giving you this ſatisfaction, give me leave to mind you, that it was a ſaying of *Pythagoras*, worthy ſo celebrated a philoſopher, that there are two things, which moſt ennoble man, and make him reſemble the gods; *to know the truth*, and *to do good*. For, *Pyrophilus*, that diviner part of man, the ſoul, which alone is capable of wearing the glorious image of its author, being endowed with two chief faculties, the underſtanding and the will; the former is bleſt and perfectionated by knowledge, and the latter's lovelieſt and moſt improving property is goodneſs. A due reflection upon this excellent ſentence of him, to whom philoſophers owe that modeſt name, ſhould, methinks, *Pyrophilus*, very much endear to us the ſtudy of natural philoſophy. For there is no human ſcience, that does more gratify and enrich the underſtanding with variety of choice and acceptable truths; nor ſcarce any, that does more enable a willing mind to exerciſe a goodneſs beneficial to others.

That experimental philoſophy is conducive to the improving of man's underſtanding and to the increaſing man's power.

To manifeſt theſe truths more diſtinctly, *Pyrophilus*, and yet without exceeding that brevity, my avocations and the bounds of an Eſſay exact of me, I ſhall, among the numerous advantages accruing to men from the ſtudy of the book of nature, content myſelf to inſtance only in a couple, that relate more properly to the *improving of men's underſtandings*, and to mention a few of thoſe many, by which it *encreaſes their power*.

THE two chief advantages, which a real acquaintance with nature brings to our minds, are, firſt, by inſtructing our underſtandings, and gratifying our curioſities; and next, by exciting and cheriſhing our devotion.

**Arguments to prove, that man's curioſity for knowledge is much thereby gratified.**

AND for the firſt of theſe: Since, as *Ariſtotle* teacheth, and was taught himſelf by common experience, *all men are naturally deſirous to know*; that propenſity cannot but be powerfully engaged to the works of nature, which being inceſſantly preſent to our ſenſes, do continually ſollicit our curioſities: of whoſe potent inclining us to the contemplation of nature's wonders, it is not, perhaps, the inconſiderableſt inſtance, that, though the natural philoſophy hitherto taught in moſt ſchools hath been ſo litigious in its theory, and ſo barren as to its productions; yet it hath found numbers of zealous and learned cultivators, whom ſure nothing but men's in-bred fondneſs for the object it converſes with, and the end it pretends to, could ſo paſſionately devote to it.

AND ſince that (as the ſame *Ariſtotle*, taught by his maſter *Plato*, well obſerves) admiration is the parent of philoſophy, by engaging us to enquire into the cauſes of the things at which we marvel; we cannot but be powerfully invited to the contemplation of nature, by living and converſing among wonders, ſome of which are obvious and conſpicuous enough to amaze even ordinary beholders; and others admirable and abſtruſe enough to aſtoniſh the moſt inquiſitive ſpectators.

**A relation of the tranſport and ſurprizal of a maid born blind, when being about 18 years old, ſhe obtained the firſt ſight of the various objects the world inſtantly preſented her with.**

THE bare proſpect of this magnificent fabrick of the univerſe, furniſhed and adorned with ſuch ſtrange variety of curious and uſeful creatures, would ſuffice to tranſport us both with wonder and joy, if their commonneſs did not hinder their operations. Of which truth, Mr. *Stepkins*, the famous oculiſt, did not long ſince ſupply us with a memorable inſtance: For (as both himſelf and an illuſtrious perſon that was preſent at the cure, informed me) a maid of about eighteen years of age, having by a couple of cataracts, that ſhe brought with her into the world, lived abſolutely blind from the moment of her birth; being brought to the free uſe of her eyes, was ſo raviſhed at the ſurprizing ſpectacle of ſo many and various objects, as preſented themſelves to her unacquainted ſight, that almoſt every thing ſhe ſaw, tranſported her with ſuch admiration and delight, that ſhe was in danger to loſe the eyes of her mind by thoſe of her body, and expound that myſtical Arabian proverb, which adviſes, *to ſhut the windows, that the houſe may be light*.

**That the knowledge of the inward architecture, and contrivances of nature is more delightful than the ſight of outward ſhapes.**

BUT if the bare beholding of this admirable ſtructure, is capable of pleaſing men ſo highly; how much ſatisfaction, *Pyrophilus*, may it be ſuppoſed to afford to an intelligent ſpectator, who is able both to underſtand and to reliſh the admirable architecture and ſkilful contrivance of it: for the book of nature is to an ordinary gazer, and a naturaliſt, like a rare book of hieroglyphicks to a child, and a philoſopher; the one is ſufficiently pleaſed with the oddneſs and variety of the curious pictures that adorn it; whereas the other, is not only delighted with thoſe outward objects, that gratify his ſenſe, but receives a much higher ſatisfaction, in admiring the knowledge of the author, and in finding out and inriching himſelf with thoſe abſtruſe and veiled truths dexterouſly hinted in them.

**Examples and inſtances of the prevalence of the pleaſure, that ariſes from the attainment of knowledge.**

YES, *Pyrophilus*, as the underſtanding is the higheſt faculty in man, ſo its pleaſures are the higheſt he can naturally receive. And therefore I cannot much wonder, that the famous *Archimedes* lighting in a bath upon an expedient to reſolve a perplexing difficulty in natural philoſophy, ſhould leap out of the bath, and run unclothed like a madman, crying nothing but ῞Ευρηκα, ῞Ευρηκα, *I have found it, I have found it.* Nor do I ſo much admire, as deplore the fatally venturous curioſity of the elder *Pliny*, who, as the younger relates, could not be deterred by the formidableneſs of deſtructive flames vomited by *Veſuvius*, from endeavouring by their light to read the nature of ſuch Vulcanian hills; but in ſpite of all the diſſuaſions of his friends, and the affrighting eruptions of that hideous place, he reſolved, that flaming wonder ſhould rather kill him, than eſcape him; and thereupon approached ſo near, that he loſt his life to ſatisfy his curioſity, and fell (if I may ſo ſpeak) a martyr to phyſiology. For we daily ſee alchymiſts hazard their lives on mineral experiments in furnaces, where, though the fires are not ſo vaſt and fierce, as thoſe that *Pliny* went to conſider, yet the (dangerous, when not pernicious) fumes, do ſometimes prove as fatal.

ONE would think, *Pyrophilus*, that the converſing with dead and ſtinking carcaſſes (that are not only hideous objects in themſelves, but made more ghaſtly by putting us in mind, that ourſelves muſt be ſuch) ſhould be not only a very melancholy, but a very hated employment. And yet, *Pyrophilus*, there are anatomiſts, who dote upon it; and I confeſs its inſtructiveneſs hath not only ſo reconciled me to it, but ſo enamoured me of it, that I have often ſpent hours much leſs delightfully, not only in courts, but even in libraries, than in tracing in thoſe forſaken manſions, the inimitable workmanſhip of the omniſcient Architect.

That the knowledge of the moſt curious artificial works is not more delightful than the knowledge of natural.

*Ariſtot.* de Part. Anim. lib. 1. c. 5.

THE curious works of famous artificers are wont to invite the viſits, and excite the wonder of the generality of inquiſitive perſons. And I remember, that in my travels, I have often taken no ſmall pains to obtain the pleaſure of gazing upon ſome maſterpiece of art: but now, I confeſs, I could with more delight look upon a ſkilful diſſection, than the famous clock at *Straſburgh*. And, methinks, *Ariſtotle* diſcourſes very philoſophically in that place, where paſſing from the conſideration of the ſublimeſt productions of nature, to juſtify his diligence in recording the more homely circumſtances of the hiſtory of animals, he thus diſcourſes: *Reſtat* (ſaith he) *ut de animanti natura diſſeramus, nihil pro viribus omittentes vel vilius vel nobilius. Nam & in iis, quæ hoc in genere minus grata noſtro occurrunt ſenſui, natura parens & autor omnium miras excitat voluptates hominibus, qui intelligunt cauſas & ingenuè philoſophantur. Abſurdum enim nulla ratione probandum eſt, ſi imagines quidem rerum naturalium non ſine delectatione propterea inſpectamus, quòd ingenium contemplamur, quod illas condiderit, id eſt, artem pingendi aut fingendi; rerum autem ipſarum naturæ ingenio mirâque ſolertia conſtitutam contemplationem non magis proſequamur atque exoſculemur, modo cauſas perſpicere valeamus:* ‘It remains (ſaith he) that we diſcourſe of the natures of animals, being circumſpect to omit none either of the nobler or inferiour ſort: for even from thoſe creatures, which leſs pleaſe our ſenſe, does the univerſal parent, nature, afford incredible contentments to ſuch perſons, as underſtand their cauſes, and philoſophize ingenuouſly. Since it were abſurd and inconſiſtent to reaſon, if we ſhould behold the portraitures of natural things with delectation, becauſe we obſerve the accurateneſs, wherewith they are deſigned, namely, the ſkill of painture or ſculpture; and not much more affect and purſue the contemplation of things themſelves, contrived by the exquiſite artifice and ſagacity of nature, provided we be able to underſtand their cauſes.’ And the better to make out to you, *Pyrophilus*, the delightfulneſs of the ſtudy of natural philoſophy, let me obſerve to you, that thoſe pleaſing truths it teacheth us, do highly gratify our intellectual faculties, without diſpleaſing any of them: for they are none of thoſe criminal pleaſures, which injured and incenſed conſcience does very much allay, even in the fruition, and turns into torments after it. Nor are the enquiries I am recommending of that trifling and unſerviceable ſort of imployments, which though conſcience condemns not as unlawful for a Chriſtian, reaſon diſapproves as not worthy of a philoſopher; and wherewith to be much delighted, argues a weakneſs; as to be pleaſed with babes and whiſtles ſuppoſes unripe and weak intellectuals: but the contemplation of nature is an imployment, which both the poſſeſſors of the ſublimeſt reaſon, and thoſe of the ſevereſt virtue, have not only allowed, but cultivated. The learned author of the book *De Mundo*, aſcribed to *Ariſtotle*,

That the delight herein is altogether inoffenſive.

begins

Inſtances of the eſteem divers antient philoſophers had for it.

*Seneca* in Præf. lib. 1. Nat. Quæſt.

*Sen.* de Otio Sap. c. 32.

How this ſtudy conſiſts with religion.

begins it with this elogium of natural philoſophy: *Mihi quidem ſæpe* (ſays he) *divina quædam res, Alexander, admirationeque digna viſa eſt philoſophia; præcipuè verò in ea parte, in qua ſola ipſa ſublimè ſeſe tollens, ad contemplandas rerum naturas magno illic ſtudio contendit exiſtentem in eis veritatem pernoſcere.* ‘Philoſophy (ſays he) O *Alexander,* ‘hath oftentimes ſeemed to me a divine and admirable thing; but chiefly, that part of ‘it, which aſpires to contemplate the natures of things, imploying its utmoſt power ‘in ſearching out the truth contained in them.’ The reaſonableneſs of which commendation he handſomely enough proſecutes in the ſubſequent diſcourſe; to which I ſhall refer you, that I may proceed to mind you, that *Pythagoras, Democritus, Plato,* and divers others of thoſe, whoſe wiſdom made after-ages reverence antiquity, did not only eſteem the truths of nature worth ſtudying for, but thought them too worth travelling for as far as thoſe eaſtern regions, whoſe wiſe-men were then cried up for the beſt expoſitors of the obſcure book of nature. And that ſevere teacher, and perſuaſive recommender of the ſtricteſt virtue, *Seneca,* (whoſe eminent wiſdom made him invited to govern him, that was to govern the world, and who ſo often and ſo excellently preſſes the huſbanding of our time) does not only in ſeveral paſſages of his writings praiſe a contemplation of nature, but writes himſelf ſeven books of natural queſtions, and addreſſes them to that very *Lucilius,* whom in his epiſtle he takes ſuch pains to make compleatly virtuous; and in his preface, after he had ſaid according to his manner, loftily, *Equidem tunc naturæ rerum gratias ago, cum illam non ab hac parte video, quæ publica eſt, ſed cum ſecretiora ejus intravi, cum diſco, quæ univerſi materia ſit, quis author, aut cuſtos, &c.* ‘Then do I pay my acknowledgments to nature, when I ‘behold her not on the outſide, which is obvious to publick view, but am entered into her more ſecret receſſes; when I underſtand what the matter of the univerſe is, ‘who its author, and preſerver, &c.’ He concludes in the ſame ſtrain, *Niſi ad hæc admitterer, non fuerat operæ pretium naſci:* ‘Had I been debarred from theſe things, it ‘would not have been worth coming into the world.’ And to add what he excellently ſays in another treatiſe, *Ad hæc querenda natus* (ſays he, having ſpoken of enquiries concerning the univerſe) *æſtima quàm non multùm acceperit temporis, etiamſi illud totum ſibi vindicet, cui licet nihil facilitate eripi, nihil negligentia patiatur excidere; licet horas ſuas avariſſimè ſervet, & uſque in ultimæ ætatis humanæ terminos procedat; nec quicquid illi, ex eo quod natura conſtituit, fortuna concutiat, tamen homo ad immortalium cognitionem nimis mortalis eſt. Ergo ſecundum naturam vivo, ſi totum me illi dedi, ſi illius admirator cultorque ſum. Natura autem utrumque facere me voluit & agere, & contemplationi vocare:* ‘Being ‘born deſignedly for ſearching out theſe things, conſider, that the portion of time allotted to man is not great, if this ſtudy ſhould ingroſs it all; ſince though he ſhould ‘preſerve his hours with the greateſt frugality all his life-time, not ſuffering any to be ‘ſtolen from him, or ſlide away negligently, and never be diſturbed by accidents of fortune in the imployment nature has appointed him, yet is he too mortal to attain the ‘knowledge of immortal things. Wherefore, I live agreeable to nature, when I give ‘up my ſelf wholly to her, and am her admirer and adorer: moreover, nature hath deſigned me to act, and imploy my ſelf in contemplation.’ How far religion is from diſ-approving the ſtudy of phyſiology, I ſhall have occaſion to manifeſt ere long, when we ſhall come to ſhew, that it is an act of piety to offer up for the creatures the ſacrifice of praiſe to the creator; for, as anciently among the Jews, by virtue of an Aaronical extraction, men were born with a right to prieſthood; ſo reaſon is a natural dignity, and knowledge a prerogative, that can confer a prieſthood without unction or impoſition of hands. And as for reaſon, that is ſo far from making us judge that imployment unworthy of rational creatures, that thoſe philoſophers (as *Ariſtotle, Epicurus, Democritus, &c.*) that have improved reaſon to the greateſt height, have the moſt ſeriouſly and induſtriouſly imployed it to inveſtigate the truths, and promote the ſtudy of natural philoſophy.

The abſurdity of not imploying human faculties on the contemplation of thoſe objects to which they are fitted.

And indeed, that noble faculty called reaſon, being conſcious of the great progreſs it may enable us to make in the knowledge of nature's myſteries, if it were induſtriouſly imployed in the ſtudy of them, cannot but, like a great commander, think it ſelf diſobliged by not being conſiderably employed. And certainly we are wanting to our ſelves, and are guilty of little leſs than our own degradation, that being by God's peculiar vouchſafement endowed with thoſe noble faculties of underſtanding, and diſcourſing, and placed amidſt a numberleſs variety of objects, that inceſſantly invite our contemplations, can content our ſelves to behold ſo many inſtructive creatures, which make up this vaſt univerſe, whoſe nobleſt part we are deſigned to be, with no more, or but little more diſcerning eyes than thoſe leſs favoured animals, to whom nature hath denied the prerogative of reaſon, as we deny our ſelves the uſe of it. *Ariſtotle* well obſerves, that among animals, man alone is of an erected ſtature; and adds, That it is becauſe his nature hath ſomething in it of divine: *Officium autem divini* (infers he) *eſt intelligere atque ſapere:* 'The qualifications of a divine being, are underſtanding and wiſdom.' And it cannot but miſbecome the dignity of ſuch a creature to live ignorant or unſtudious of the laws and conſtitutions of that great commonwealth (as divers of the antients have not improperly ſtyled the world) whereof he is the eminenteſt part. And were we not lulled aſleep by cuſtom or ſenſuality, it could not but trouble, as well as it injures a reaſonable ſoul, to ignore the ſtructure and contrivance of that admirably organized body, in which ſhe lives, and to whoſe intervention ſhe owes the knowledge ſhe hath of other creatures.

De Part. Anim. lib. 4. c. 10.

It is true indeed, that even the generality of men, without making it their deſign, know ſomewhat more of the works of nature, than creatures deſtitute of reaſon, can, by the advantage of that ſuperiour faculty, which cannot but even unurged, and of its own accord make ſome, though but ſlight, reflections on the information of the ſenſes: but if thoſe impreſſions be only received and not improved, but rather neglected; and if we (contenting our ſelves with the ſuperficial account given us of things by their obvious appearances and qualities) are beholden for that we know, to our nature, not our induſtry, we faultily loſe both one of the nobleſt imployments, and one of the higheſt ſatisfactions of our rational faculty. And he, that is this way wanting to himſelf, ſeems to live in this magnificent ſtructure, called the univerſe, not unlike a ſpider in a palace; who taking notice only of thoſe objects, that obtrude themſelves upon her ſenſes, lives ignorant of all the other rooms in the houſe, ſave that wherein ſhe lurks; and diſcerning nothing either of the architecture of the ſtately building, or of the proportion of the parts of it in relation to each other, and to the entire ſtructure, makes it her whole buſineſs, by intrapping of flies, to continue an uſeleſs life; or exerciſe herſelf to ſpin cobwebs, which, though conſiſting of very ſubtile threads, are unſerviceable for any other than her own trifling uſes. And that the contemplation of the world, eſpecially the higher region of it, was deſigned for man's imployment by nature's ſelf, even the heathen poet (perhaps inſtructed by *Ariſtotle*) could obſerve, who ſings,

Illuſtrated by the ſimilitude of a ſpider in a palace, taking notice of nothing beſide her own cobweb.

*Pronaque cum ſpectent animalia cætera terram,*
*Os homini ſublime dedit, cœlumque tueri*
*Juſſit, & erectos ad ſidera tollere vultus.*

'Wiſe nature, framing brutes with downward looks,
'Man with a lofty aſpect did endue,
'And bad him heaven with its bright glories view.

The opinion that *Ovid, Seth, Abraham,* and *Solomon* had of man's fitneſs for the ſtudy of aſtronomy and other phyſiology. *Iſaiah* xli. 8. *James* xi. 23.

I might annex, *Pyrophilus*, the ſtory *Joſephus* tells us in the beginning of his *Jewiſh Antiquities*, that it was the holy *Seth* and his poſterity (who are in *Geneſis* ſtyled the ſons of God) that were the inventors of aſtronomy, whoſe more fundamental obſervations (to perpetuate them to mankind, and ſever them from the foretold deſtructions by fire and water) they engraved upon two pillars, the one of brick, the other of ſtone; the latter of which our hiſtorian reports to have been extant in *Syria* in his time. And it is an almoſt uncontrolled tradition, that the patriarch, whom God vouchſafes to ſtyle *his friend*, was the firſt teacher of aſtronomy and philoſophy to the Egyptians, from whom, long afterwards, the Grecians learned them. *Beroſus* himſelf records him to have been ſkilled in the ſcience of the ſtars, as he is cited by *Joſephus*, (*Ant.* lib. 1. c. 8.) who a little after ſpeaking of *Abraham* and the Egyptians, expreſly affirms, that *Numerorum ſcientiam & ſiderum benignè illis communicavit: nam ante Abrahami ad ſe adventum, Ægyptii rudes erant hujuſmodi diſciplinarum*; *quæ à Chaldæis ad Ægyptios profectæ, hinc ad Græcos tandem pervenerunt.*

But, *Pyrophilus*, to put it out of queſtion, that the ſublimeſt reaſon needs not make the poſſeſſor of it think the ſtudy of phyſiology an employment below him, that unequalled *Solomon*, who was pronounced the wiſeſt of men by their omniſcient Author, did not only juſtify the ſtudy of natural philoſophy, by addicting himſelf to it, but ennobled it by teaching it, and purpoſely compoſing of it, thoſe matchleſs records of nature, from which I remember ſome Jewiſh authors relate *Ariſtotle* to have borrowed divers; which (if it be true) may well be ſuppoſed to be the choiceſt pieces, that adorned his philoſophy, and which Providence perhaps deprived the world of, upon ſuch a ſcore, as it did the Jews of the body of *Moſes*, leſt men ſhould idolize it, or, as ſome Rabbies are pleaſed to inform us, leſt vicious men ſhould venture upon all kinds of intemperance, out of confidence of finding out by the help of thoſe excellent writings the cure of all the diſtempers their diſſoluteneſs ſhould produce.

Why Providence might deprive us of *Solomon*'s phyſiology.

And, *Pyrophilus*, yet a little further to diſcover to you the delightfulneſs of the contemplations of nature's works, give me leave to mind you of their almoſt unimaginable variety, as of a property, that ſhould, methinks, not faintly recommend natural philoſophy to curious and active intellectuals.

Of the delight, that may ariſe from the variety of objects, which nature produces.

For moſt other ſciences, at leaſt as they are wont to be taught, are ſo narrow and circumſcribed, that he, who has read one of the beſt and recenteſt ſyſtems of them, ſhall find little in the other books publiſhed on thoſe ſubjects, but diſguiſed repetitions; and a diligent ſcholar may in no long time learn, as much as the profeſſors themſelves can teach him. But the objects of natural philoſophy being as many as the laws and works of nature, are ſo various and ſo numberleſs, that if a man had the age of *Methuſelah* to ſpend, he might ſooner want time than matter for his contemplations: and ſo pregnant is each of that vaſt multitude of creatures, that make up the naturaliſt's theme, with uſeful matter to employ men's ſtudy, that I dare ſay, that the whole life of a philoſopher ſpent in that alone would be too ſhort to give a full and perfect account of the natural properties and uſes of any one of ſeveral minerals, plants, or animals, that I could name. It is an almoſt incredible variety of vegetables, that the teeming earth, impregnated by God's *producat terra*, does in ſeveral regions produce. Botaniſts have, a pretty while ſince, reckoned up near 6000 ſubjects of the vegetable kingdom; ſince when, divers other not deſcribed plants have been obſerved by herbariſts, the chief of which will, I hope, be ſhortly communicated to the world, by that curious and diligent botaniſt, my induſtrious acquaintance, Dr. *How*, to whom I not long ſince preſented a peculiar and excellent kind of pepper, whoſe ſhell taſtes not unlike cinnamon, and ſmells ſo like cloves, that with the odour I have deceived many, which he confeſt to be new even to him; it having been lately gathered in *Jamaica* (where it abounds)

That there be above 6000 ſubjects of the vegetable kingdom.

Of an excellent *Jamaica* pepper newly brought over.

and preſented me by the inquiſitive commander of the Engliſh forces there. And yet, *Pyrophilus*, this great variety of ſimples could not deter either ancient or modern inquirers from writing entire treatiſes of ſome particular ones. So *Pliny* tells us, [a] that *Themiſon* the phyſician publiſhed a volume (for ſo he called it) of that vulgar and deſpiſed herb called Plantain. So the ſame [b] author tells us, that *Amphilocus* writ a volume *De Medica Herba, & Cytiſa*; and king [c] *Juba* another, of a ſort of *Nymphæ* by him found on mount *Atlas*. And in our times, not to mention thoſe many books, that have been written by phyſicians, of the ſtructure of man's body, and *De Uſu partium*, *Carolus Roſenbergius* writ ſome years ſince an entire book *of Roſes*, which he calls his *Rhodologia*: *Martinus Blochwitius* ſince publiſhed another book *of Elder*, under the title of *Anatomia Sambuci*. Among the chymiſts, *Angelus Sala* publiſhed in diſtinct treatiſes, his *Vitriologia*, *Tartarologia*, *Saccharologia*. *Untzerus* alſo writ peculiar tracts *De Mercurio*, *De Sulphure*, *De Sale*. And *Paracelſus* himſelf vouchſafed diſtinct treatiſes to *Hypericon*, *Perſicaria*, *Helleborus*, and ſome other particular plants. *Baſilius Valentinus* (one of the moſt knowing and candid chymical writers) publiſhed long ſince an excellent treatiſe of *Antimony* inſcribed *Currus triumphalis Antimonii*; but though in his other, he hath alſo taught us divers other things concerning it, yet he left ſo much undiſcovered in antimony, that *Angelus Sala* was thereby emboldened to publiſh his *Anatomia Antimonii*. And *Hamerus Poppius*, (if that be his true name) *Johannes Tholdius*, and the experienced *Alexander Van Suchten*, thought fit to write entire treatiſes of that ſame mineral, by which if they ſeem to eclipſe the diligence of *Baſilius*, at leaſt they bore witneſs to his judgment: for modeſtly inviting his readers to make further inquiries into the nature and preparations of that abſtruſe mineral, he gives this account of his leaving many things unmentioned, *That the ſhortneſs of life makes it impoſſible for one man throughly to learn antimony, in which every day ſomething of new is diſcovered.* And I remember, that having lately given a chymiſt, upon his requeſt, ſome directions for drawing, not an imaginary mercury of antimony, as thoſe, which are wont to be taught by chymiſts, but a real fluid quickſilver; he ſome days ſince brought me about an ounce of it (which you may command when you pleaſe) as the firſt fruits of directions, differing enough from thoſe, which I have hitherto met with in authors. A peculiar way likewiſe of ſeparating from antimony, not ſuch a ſubſtance as thoſe, which are as improperly as vulgarly called antimonial ſulphurs, but a really combuſtible body, which looks and burns ſo like common brimſtone, that it is not eaſily diſtinguiſhable from it, we ſhall elſewhere, God willing, *Pyrophilus*, teach you. And I remember, that whereas, according to the way mentioned by *Baſilius* in his *Currus triumphalis*, and both generally tranſcribed by authors, and formerly practiſed by our ſelves, the tincture of the glaſs of antimony is very tedious to make, being to be drawn with ſpirit of vinegar, I once made a menſtruum to draw it more expeditiouſly; which having not hitherto met with, in any of the authors I have read, I ſhall not conceal from you. Taking then an arbitrary quantity of the beſt French verdigreaſe, and diſtilling it orderly in a ſtrong naked fire, I found the extorted liquor to extract (even in an ordinary digeſting heat) from powdered antimonial glaſs, a blood-red tincture in three or four hours; and my curioſity leading me to abſtract the menſtruum from the tinging powder, and put it again upon pulveriſed glaſs, I found it again highly tincted in very few hours. And proſecuting the experiment, I found, that by drawing off the menſtruum, and digeſting ſpirit of wine upon the remaining calx, I could ſoon obtain a red tincture, or ſolution; from which ſome chymiſts, if I ſhould tell them, what I have now told you, would perhaps expect no ordinary medicine. But this, I ſuppoſe, you will think leſs ſtrange, than that with a liquor eaſily ſeparated, by a way which I may elſewhere teach you, from an obvious vegetable, of which you may ſafely eat a whole pound at a time, I have drawn

Of divers ſingle ſubjects that require large treatiſes to unfold them.

How many treatiſes are already made of antimony, which yet has not been perfectly diſcovered.

Of a real mercury of antimony.

And a real combuſtible ſulphur of antimony, that burns like ordinary brimſtone.

A new tincture of antimonial glaſs, with the intire proceſs to draw it.

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[a] *Plin.* lib. xxv. cap. 8.

[b] Id. lib. xviii. cap. 26.

[c] Id. lib. xxv. cap. 7.

a deep red tincture, even from crude antimony, and that in not many hours, and without heat.

Of *Gilbertus*, *Cabæus*, and *Kircher*, who ſucceſſively writ the experiments of the load-ſtone.

Of ſome new experiments hitherto undiſcovered of that ſtone.

AND to theſe experiments of antimony, I might (partly from the communication of my friends, and partly from ſome trials of my own) add divers other undivulged experiments relating to that mineral, if it were not now more ſeaſonable, reſerving them for other papers, to mind you, that the learned *Kircherus* hath enriched us with a great volume in folio, of light and ſhadows; and another in quarto, of the load-ſtone: and yet none of theſe have ſo exhauſted the ſubjects they have treated of, but that an after enquirer may be able to recruit their obſervations with many new ones, perhaps more numerous or more conſiderable than the former: as after our learned countryman *Gilbertus* had written a volume of the load-ſtone, the Jeſuit *Cabæus* was not by that deterred from writing another of the ſame ſubject: and though ſince *Cabæus* the ingenious *Kircherus* have ſo largely proſecuted it in his voluminous *Ars Magnetica*, yet he has not reaped his field ſo clean, but that a careful gleaner may ſtill find ears enough to make ſome ſheaves. And what I have lately tried or ſeen, makes me think it very poſſible to recruit thoſe many of *Kircherus*, with ſome further magnetical experiments unmentioned in his book. And I have, the very day I writ this, made in that admirable ſtone a not inconſiderable experiment, not extant (that I remember) there: for taking an oblong load-ſtone, and heating it red-hot, I found the attractive faculty in not many minutes, either altogether aboliſhed, or at leaſt ſo impaired and weakened, that I was ſcarce, if at all able to diſcern it. But this hath been obſerved, though not ſo faithfully related, by more than one; wherefore I ſhall add, that by refrigerating this red-hot load-ſtone either north or ſouth, I found that I could give its extremes a polarity (if I may ſo ſpeak) which they would readily diſplay upon an excited needle freely placed in æquilibrium: and not only ſo, but I could by refrigerating the ſame end ſometime north, and ſometime ſouth, in a very ſhort time change the poles of the load-ſtone at pleaſure, making that which was a quarter of an hour before the north pole, become the ſouth; and on the contrary, the formerly ſouthern pole become the northern. And this change was wrought on the load-ſtone, not only by cooling it directly north and ſouth, but by cooling it perpendicularly; that end of it which was contiguous to the ground growing the northern pole, and ſo (according to the laws magnetical) drawing to it the ſouth end of the needle; and that which was remoteſt from it, the contrary one: as if indeed the terreſtrial globe were, as ſome magnetick philoſophers have ſuppoſed it, but a great *Magnes*, ſince its effluviums are able, in ſome caſes, to impart a magnetick faculty to the loadſtone it ſelf. Some other experiments of this nature, not extant in *Kircherus*, we may have elſewhere fit opportunity to mention. And indeed, that ænigmatical mineral (if I may ſo call it) the load-ſtone, is a ſubject ſo fertile in rarities, that, I hear, he himſelf is reprinting that accurate treatiſe, with new large additions.

That admirable ſpeculations may ariſe from the moſt deſpicable productions of nature.

NOR are the ſmalleſt and moſt deſpicable productions of nature ſo barren, but that they are capable both to invite our ſpeculations, and to recompenſe them. *Pliny* in the eleventh book of his natural hiſtory, where he treats of inſects, is a little after the entrance tranſported with an unwonted admiration of the workmanſhip of nature in them: *Nuſquam alibi* (ſays he) *ſpectatiore naturæ rerum artificio:* ‘ In nothing elſewhere (ſaith ‘ he) is the workmanſhip of nature more remarkable than in the contexture of theſe ‘ little creatures.’ And after a wonder, not unworthy a philoſopher, he concludes, *Rerum natura nuſquam magis quam in minimis tota eſt:* ‘ Nature in her whole power is ‘ never more wholly ſeen than in her ſmalleſt works.’ To which *epiphonema* he adds this ſober and philoſophical admonition: *Quapropter, quæſo, ne hæc legentes, quoniam ex his ſpernunt multa, etiam relata faſtidio damnent, cum in contemplatione naturæ nihil poſſit videri*

*videri ſupervacaneum:* ‘Wherefore I would requeſt the peruſers of theſe diſcourſes, that although the ſubjects we treat of are contemptible in their eyes, they would not therefore diſdain the relations we ſhall make of them; ſince nothing ought to ſeem ſuperfluous in the contemplation of nature.’ I remember, that it is from the conſideration of ſo deſpicable a part as the ſkin of the ſoal of the foot, that *Galen* takes occaſion to magnify the wiſdom of God in thoſe excellent terms, that we ſhall have occaſion to mention hereafter. And, as he ſays rarely well, though ſome creatures ſeem made of much coarſer ſtuff than others, yet even in the vileſt, the Maker's art ſhines through the deſpicableneſs of the matter. For idiots admire in things the beauty of their materials; but artiſts, that of the workmanſhip: to which, after a great deal of philoſophical diſcourſe, he adds, *Neque oculo nec cerebro deterius eſt pes conſtructus, ſi utraque pars ad actiones, cujus gratia fuit facta, ſe habeat optimè; neque cerebrum ſine pede ſe probe haberet, neque pes ſine cerebro: eget enim, opinor, illud vehiculo, hic autem ſenſu:* ‘Nor is the foot worſe contrived than the brain or eye, provided each part be duly diſpoſed for the performance of the actions to which it was deſigned: ſince the brain could not conveniently want the foot, nor the foot the brain. For, I conceive, that one ſtands in need of a ſupport for local motion; and the other, of a ſource, from whence to derive the faculties of feeling.’ To which we may annex that judicious reaſoning of *Ariſtotle*, who, deſcending from the contemplation of the ſublimer works of nature, to treat of the parts of animals, thus endeavours to keep his readers from thinking, that the object of it muſt render that enquiry deſpicable: *Reſtat* (ſays he) *ut de animanti natura diſſeramus.* And having ſet down thoſe words, which you have not long ſince read, in connection to theſe, he thus proſecutes his diſcourſe: *Quamobrem, viliorum animalium diſputationem perpenſionemque faſtidio quodam puerili ſpreviſſe, moleſtéque tuliſſe dignum nequaquam eſt: cum nulla res ſit naturæ, in qua non mirandum aliquod habeatur. Et quod Heraclitum ferant dixiſſe ad eos, qui cum alloqui eum vellent, quòd fortè in caſa furnaria quadam caloris gratia ſedentem vidiſſent, accedere temperarunt, ingredi enim eos fidenter juſſit; quoniam, inquit, ne huic quidem loco dii deſunt immortales; hoc idem in indaganda quoque natura animantium faciendum eſt. Aggredi enim quæque ſine ullo pudore debemus; cum in omnibus naturæ numen, & honeſtum pulchrumque inſit ingenium:* ‘Wherefore it is altogether unſeemly to reject with a kind of childiſh nicety, or be offended at the diſcourſe and ſpeculation of inferior animals; ſince there is nothing in all nature, but contains in it ſomewhat worthy of admiration. And as it is recorded of *Heraclitus*, that ſeeing ſome perſons deſirous to ſpeak with him, refuſed to approach towards him, becauſe they beheld him warming himſelf in a miſerable cottage, he bad them come in without ſcruple, ſince here alſo (ſaith he) are the immortal gods preſent: ſo in like manner ought we to be highly perſuaded of the dignity of animals, when we make enquiries into their natures. Which we ought in no wiſe to be aſhamed of; ſince the mighty power and laudable wiſdom of nature is conſpicuous in all things.’ Nay, *Paracelſus* himſelf, as haughty as he was, was philoſopher enough not to diſdain to write a book *De Myſteriis Vermium*; wherein, though, according to his manner, he hath ſet down many extravagances, he is more candid in the delivery of ſeveral remedies (which experience hath recently taught us to be more effectual than probable) than in moſt other of his writings. And in that treatiſe he juſtly reprehends the lazineſs and pride of thoſe phyſicians, who not only neglect and ſcorn enquiries of nature themſelves, but when the fruits of ſuch enquiries are preſented them by others, inſtead of a grateful acceptance, receive them with contempt and deriſion. To which, a while after, he adds, what is moſt true, ‘That God hath created nothing ſo vile, deſpicable, abject, or filthy in the world, that may not make for the health and uſe of man.’ And certainly, whatever God himſelf has been pleaſed to

Whatever God has thought worthy of making, man ſhould not think unworthy of knowing.

think worthy his making, its fellow-creature man ſhould not think unworthy of his knowing. Nor is it a diſparagement to a human notion, to repreſent a creature, which has the honour to have been framed according to a divine idea; and therefore the wiſeſt of men, in his natural hiſtory, ſcruples not to write as well of abject reptiles, as of lions, eagles, elephants, and other noble animals; and did not only treat of the tall cedars of *Lebanon*, but that deſpicable plant (whatever it be that is deſigned by the Hebrew *ezob*) which grows out of the wall. For my part, if I durſt think my actions fit to be examples, I ſhould tell you, that I have been ſo far from that effeminate ſqueamiſhneſs, that one of the philoſophical treatiſes, for which I have been gathering experiments, is of the nature and uſe of dungs. And though my condition does (God be praiſed) enable me to make experiments by others hands; yet I have not been ſo nice, as to decline diſſecting dogs, wolves, fiſhes, and even rats and mice, with my own hands. Nor, when I am in my laboratory, do I ſcruple with them naked to handle lute and charcoal.

I SHOULD here, *Pyrophilus*, ceaſe to entertain you with diſcourſes of the pleaſantneſs of natural philoſophy, but that I remember I have not yet told you, that the ſtudy of phyſiology is not only delightful, as it teaches us to know nature, but alſo as it teaches us in many caſes to maſter and command her. For the true naturaliſt (as we ſhall ſee hereafter) does not only know many things, which other men ignore, but can perform many things, which other men cannot do; being enabled by his ſkill not barely to underſtand ſeveral wonders of nature, but alſo partly to imitate, and partly to multiply and improve them. And how naturally we affect the exerciſe of this power over the creatures, may appear in the delight children take to do many things (which we may have occaſion to mention elſewhere) that ſeem to proceed from an innate propenſity to pleaſe themſelves in imitating or changing the productions of nature.

Of the dominion and power that phyſiology gives the proſperous ſtudiers of it.

AND ſure it is a great honour, that the indulgent Creator vouchſafes to naturaliſts, that though he gives them not the power to produce one atom of matter, yet he allows them the power to introduce ſo many forms (which philoſophers teach to be nobler than matter) and work ſuch changes among the creatures, that if *Adam* were now alive, and ſhould ſurvey that great variety of man's productions, that is to be found in the ſhops of artificers, the laboratories of chymiſts, and other well furniſhed magazines of art, he would admire to ſee what a new world, as it were, or ſet of things has been added to the primitive creatures by the induſtry of his poſterity.

AND though it be very true, that man is but the miniſter of nature, and can but duly apply agents to patients, (the reſt of the work being done by the applied bodies themſelves;) yet by his ſkill in making thoſe applications, he is able to perform ſuch things, as do not only give him a power to maſter creatures otherwiſe much ſtronger than himſelf, but may enable one man to do ſuch wonders, as another man ſhall think he cannot ſufficiently admire. As the poor Indians looked upon the Spaniards as more than men, becauſe the knowledge they had of the properties of nitre, ſulphur and charcoal duly mixed, enabled them to thunder and lighten ſo fatally, when they pleaſed. And this empire of man, as a naturaliſt, over the creatures may perchance be to a philoſophical ſoul preſerved by reaſon untainted with vulgar opinions, of a much more ſatisfactory kind of power or ſovereignty than that, for which ambitious mortals are wont ſo bloodily to contend. For oftentimes this latter being commonly but the gift of nature, or preſent of fortune, and but too often the acquiſt of crimes, does no more argue any true worth or noble ſuperiority in the poſſeſſor of it, than it argues one braſs counter to be of a better metal than its fellows, in that it is choſen out to ſtand in the account for many thouſands pounds more than any of them. Whereas the dominion, that phyſiology gives the proſperous ſtudier of it (beſides that it is wont to be innocently acquired, by being the effect of his knowledge) is a power, that becomes man as man. And to an ingenious ſpirit, the wonders he performs bring perchance a higher ſatisfaction, as they are proofs of his knowledge, than as they are productions of his power, or even bring acceſſions to his ſtore.

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## ESSAY II. *Of the ſame.*

That the knowledge of nature excites and cheriſhes devotion.

THE next advantage, *Pyrophilus*, that we mentioned the knowledge of nature to bring to the minds of men, is, that therein it excites and cheriſhes devotion; which when I ſay, *Pyrophilus*, I forget not, that there are ſeveral divines (and ſome of them eminent ones) that out of a holy jealouſy (as they think) for religion, labour to deter men from addicting themſelves to ſerious and thorough inquiries into nature, as from a ſtudy unſafe for a Chriſtian, and likely to end in atheiſm, by making it poſſible for men (that I may propoſe to you their objection as much to its advantage as I can) to give themſelves ſuch an account of all the wonders of nature, by the ſingle knowledge of ſecond cauſes, as may bring them to diſbelieve the neceſſity of a firſt. And certainly, *Pyrophilus*, if this apprehenſion were well grounded, I ſhould think the threatened evil ſo conſiderable, that inſtead of inviting you to the ſtudy of natural philoſophy, I ſhould very earneſtly labour to diſſuade you from it. For I, that had much rather have men not philoſophers than not Chriſtians, ſhould be better content to ſee you ignore the myſteries of nature than deny the author of it. But though the zeal of their intentions keep me from harbouring any unfavourable opinion of the perſons of theſe men, yet the prejudice that might redound from their doctrine (if generally received) both to the glory of God from the creatures, and to the empire of man over them, forbids me to leave their opinion unanſwered; though I am ſorry, that the neceſſity of vindicating the ſtudy I recommend to you from ſo heinous a crime as they have accuſed it of, will compel me to theologize in a philoſophical diſcourſe: which that I may do, with as much brevity as the weight and exigency of my ſubject will permit, I ſhall content myſelf only in the explication of my own thoughts, to hint to you the grounds of anſwering what is alledged againſt them.

The end of God's creation: his own glory. *Job* viii. 9.

AND firſt, *Pyrophilus*, I muſt premiſe, that though it may be a preſumption in man, (who to uſe a Scripture expreſſion, *is but of yeſterday, and knows nothing, becauſe his days upon the earth are but as a ſhadow*) preciſely and peremptorily to define all the ends and aims of the omniſcient God in his great work of the creation; yet perhaps, it will be no great venture to ſuppoſe, that at leaſt in the creating of the ſublunary world, and the more conſpicuous ſtars, two of God's principal ends were, the manifeſtation of his own glory, and the good of men. For the firſt of theſe; *The Lord hath made all things for himſelf*, ſays the preacher; *for of him, and through him, and to him, are all things*, ſays the apoſtle. And, *Thou haſt created all things, and for thy pleaſure they are and were created*, ſay the twenty-four proſtrate elders (repreſentatives, perhaps, of the whole church of both teſtaments, propagated by the twelve patriarchs, and the like number of apoſtles) to their Creator; which truth, were it requiſite, might be further confirmed by ſeveral other texts, which, to decline needleſs prolixity, I here forbear to inſiſt on. Conſonantly to this, we hear the Pſalmiſt proclaiming that *the heavens declare the glory of God, and the firmament ſheweth his handy-works*. To which purpoſe we may alſo obſerve, that though man were not created, till the cloſe of the ſixth day (the reſident's arrival being obligingly ſuſpended till the palace was made ready to entertain him)

*Prov.* xvi. 4.

*Rom.* xi. 36.

*Pſal.* xix. 1.

him) yet, that none of God's works might want intelligent ſpectators and admirers, the angels were created the firſt day, as divines generally infer from the words of God in *Job*; *Where waſt thou, when I laid the foundations of the earth?* and a little after; *when the morning ſtars ſang together, and all the ſons of God ſhouted for joy.* Where, by the *morning ſtars* and *ſons of God*, are ſuppoſed to be meant the newly created angels; one of whoſe earlieſt exerciſes was, it ſeems, to applaud the creation, and take thence occaſion to ſing hymns to the almighty author of it. I ſhould not, *Pyrophilus*, add any thing further on this ſubject, but that having ſince the writing of theſe thoughts, met with a diſcourſe of *Seneca*'s, very conſonant to ſome of them, I ſuppoſe it may tend to your delight as well as to their advantage, if I preſent you ſome of the truths you have ſeen in my coarſer language, dreſt up in his finer and happier expreſſions. *Curioſum nobis* (ſaith he) *natura ingenium dedit, & artis ſibi pulchritudiniſque conſcia ſpectatores nos tantis rerum ſpectaculis genuit, perditura fructum ſui, ſi tam magna, tam clara, tam ſubtiliter ducta, tam nitida, & non uno genere formoſa ſolitudini oſtenderet; ut ſcias illam ſpectari voluiſſe, non tantum aſpici, vide quem locum nobis dedit; nec erexit tantummodo hominem, ſed etiam ad contemplationem factum, ut ab ortu ſidera in occaſum labentia proſequi poſſet, & vultum ſuum circumferre cum toto, ſublime illi fecit caput, & collo flexibili impoſuit. Deinde ſena per diem, ſena per noctem ſigna produxit; nullam non partem ſui explicuit, ut per hæc, quæ obtulerat ejus oculis, cupiditatem faceret etiam cæterorum: nec enim omnia nec tanta viſimus quanta ſunt, ſed acies noſtra aperit ſibi inveſtigando viam, & fundamenta veri jacit, ut inquiſitio tranſeat ex apertis in obſcura, & aliquid ipſo mundo inveniat antiquius:* ‘Nature, ‘conſcious to her ſelf of her own beauty and artifice, hath given us a curious ſearching ‘wit, and to ſo excellent and great ſhews begat us to be ſpectators; otherwiſe ſhe ‘would have loſt the fruit of herſelf, if to a deſart and ſolitude ſhe ſhould have ſet forth ‘ſo magnificent, ſo famous, ſo finely drawn, ſo fair and many ways beautiful pieces. ‘That you may know ſhe would not only have them ſeen, but looked upon, take no‘tice of the place ſhe hath given us: for ſhe hath not only made man of an upright ‘ſtature, but being ſo made, for better contemplation, that he might follow with his ‘eye the courſe of the ſtars, from the riſing to the ſetting, and carry about his looks, ‘together with his whole body, ſhe hath both given him a tall head, and placed that ‘upon a flexible neck; then ſhe ſhews ſix conſtellations by day, and ſix by night. She ‘hath laid open every part of her ſelf, that by thoſe things, which ſhe hath offered to ‘the eyes of man, ſhe might breed a deſire of knowing the reſt. Yet neither do we ‘ſee all her works, nor thoſe that we ſee, do we ſee in thoſe proportions which they ‘truly have; but our ſight, by ſearching, does open a way unto it ſelf, and lay the ‘grounds of truth, that ſo inquiry may paſs from things that are plain, to things that ‘are obſcure, and find ſomewhat more ancient, even than the world it ſelf.’ See *Sen. De Vita Beata*, cap. xxxii. And leſt you might be offended at his mentioning of nature, and ſilence of God, give me leave to inform you, that about the cloſe of the chapter immediately preceding that, whence the paſſage you come from reading is tranſcribed, having ſpoken of the enquiries of philoſophers into the nature of the univerſe, he adds, *Hæc qui contemplatur, quid Deo præſtat? ne tanta ejus opera ſine teſte ſint*; ‘What does he, that contemplates the nature of the univerſe, of honour unto God? ‘this, that his great works are not without a witneſs.’

*Job* xxxviii. 57.

*Sen.* de Otio Sap. 32.

That man's good is a ſecond end, proved by ſcripture. *Gen.* i. 28, 29.

AND to proceed to that, which we have formerly aſſigned for the ſecond end of the creation; that much of this viſible world was made for the uſe of man, may appear, not only from the time of his creation (already taken notice of) and by the commiſſion given to the firſt progenitors of mankind, *to repleniſh the earth and ſubdue it, and to have dominion over the fiſh of the ſea, and over the fowls of the air, and over all the earth, and over every living thing that creepeth or moveth on the earth:* but alſo by God's making thoſe noble and vaſt luminaries, and other bodies, that adorned the ſky, to give light upon the earth, though inferiour to them in dimenſions, and *to divide between the day and between the night, and to be for ſigns, and for ſeaſons, and for days, and for years.* To this agrees that paſſage in the prophet, *Thus ſaith the Lord that created the heavens, God himſelf that formed the earth, and made it, He hath eſtabliſhed it, He created it not in vain, He formed it to be inhabited, &c.* And the inſpired poet ſpeaks of man's dignity in very comprehenſive terms, *For thou* (ſays he to his Maker) *haſt made him little lower than the angels, and haſt crowned him with glory and honour; Thou madeſt him to have dominion over the works of thy hands, thou haſt put all things under his feet.*

*Gen.* i. 14, 16.

*Iſai.* xlv. 28.

*Pſal.* v. 5, 6.

THE ſame truth may be confirmed by divers other texts, which it might here prove tedious to inſiſt on. And therefore I ſhall rather obſerve, that conſonantly thereunto, God was pleaſed to conſider man, ſo much more than the creatures made for him, that he made the ſun it ſelf at one time to ſtand ſtill, and at another time to go back, and divers times made the parts of the univerſe forget their nature, or act contrary to it; and has (in ſum) vouchſafed to alter by miracles the courſe of nature, for the inſtruction or relief of man (as when the fire ſuſpended its deſtructive operation, whilſt the three reſolute Jews, with their protector, walked unharmed in the midſt of thoſe flames that deſtroyed the kindlers; and as the heavy iron, emerged up to the ſwimming piece of wood, miraculouſly by *Eliſha* made magnetical.) And you may alſo, *Pyrophilus*, take notice, that when *Adam* had tranſgreſſed, immediately the ground was curſed for his ſake. And as it is not unuſual in human juſtice to raze the very houſes of regicides and reſembling traitors; ſo when the provocations of *Sodom* ſwelled high enough to reach heaven, God did not only deſtroy the inhabitants from the face of the earth, but for the inhabitants ſins deſtroyed the very face of the earth. So when in *Noah*'s time, a deluge of impiety called for a deluge of waters, God, looking upon the living creatures, as made for the uſe of man, ſtuck not to deſtroy them with him, and for him; but involved in his ruin all thoſe animals, that were not neceſſary to the perpetuation of the ſpecies, and the ſacrifice due for *Noah*'s preſervation. And ſo, when (in the laſt days) the earth ſhall be repleniſhed with thoſe ſcoffers mentioned by St. *Peter*, *who will walk after their own luſts*, and deride the expectation of God's foretold coming to judge and puniſh the ungodly, their impiety ſhall be as well puniſhed as ſilenced by the unexpected flames (perhaps haſtened by that very impiety) that ſhall either deſtroy or transfigure the world. For as by the law of *Moſes*, the leprous garment, which could not be recovered by being waſhed in water, was to be burned in the fire; ſo the world, which the deluge could not cleanſe, a general conflagration muſt deſtroy.

*Gen.* ii. 26, 28, 29.
*Pſal.* viii. 7.
*Heb.* ii. 7.
*Job* v. 3.
*Ho.* ii. 20, 21, 22.
*Rom.* viii. 28.
2 *Cor.* iii. 22.
2 *Tim.* iv. 3.
2 *Kings* vi. 5, 6.

2 *Pet.* iii. 3, 5, 6, 7, 8, 10.

*Lev.* xiii. 54, 55.

NOR is reaſon it ſelf backward to countenance what we teach. For it is no great preſumption to conceive, that the reſt of the creatures were made for man, ſince he alone of the viſible world is able to enjoy, uſe, and reliſh many of the other creatures, and to diſcern the omniſcience, almightineſs, and goodneſs of their author in them, and return him praiſes for them. It is not for themſelves, that the rubies flame, other jewels ſparkle, the bezoar-ſtone is antidotal; not is it for their own advantage, that fruitful trees ſpend and exhauſt themſelves in annual profuſions. The light, which he diffuſes through the world, is uſeleſs to the ſun himſelf, whoſe inanimate being makes him incapable of delighting in his own ſplendor, which he receives but to convey it to the earth, and other by him illuminated globes: whence probably the Hebrews called him *Shemeſh*, which grammarians derive from the root *Shemaſh*, ſignifying, in the Chaldean tongue, *to ſerve*, or *miniſter to*; the ſun being the great miniſter of nature, and ſervant general of the univerſe. And as animals alone, among the creatures, ſeem to have a proper ſenſe of, and complacency in, their own being; ſo man alone among animals is endowed with reaſon, at leaſt ſuch a pitch of it, as by which he can diſcern God's creatures

The ſame proved by reaſon and authority, xxvi, xxvii, xxviii.

How the ſun (*Shemeſh*) is the great miniſter of the univerſe.

In Probl. de Creat.

Prov. x. 25. Gen. vi. 9.

2 Pet. ii. 5.

Gen. viii. 21, 22.

Secundo De Ira, cap. 27.

De Ira Dei, cap. 13.

De Benef. cap. 28.

tures to be the gifts of God, and refer them to their Creator's glory. This truth I find not only embraced by Chriſtians, but aſſented to even by Jews and Heathens. Among the Jews, my learned acquaintance, *Manaſſeh Ben Iſrael*, profeſſedly labours to prove it by ſcripture and tradition, (though in ſome of his arguments, he might appear more a philoſopher, if he would have appeared leſs a Rabbi) and among other paſſages I remember he alledges that, wherein the wiſe man ſays (as our tranſlators engliſh it) *that the righteous is an everlaſting foundation*, which he renders, *juſtus eſt columna mundi*, *the juſt man is the pillar of the world.* And indeed, if the context did not ſomewhat disfavour the interpretation, the Hebrew words [*tzadîk yeſôd olâm*] would well enough bear the ſenſe aſſigned them. Congruouſly whereunto, I remember, that when *Noah* (who is called in ſcripture a righteous man, and κήρυξ δικαιοσύνης, a *herald*, or *proclaimer of righteouſneſs)* offered up that noble ſacrifice of all the ſorts of clean beaſts and fowls, as a thank-offering for the reprieve of the world, God is ſaid to have *ſmelled a ſavour of reſt*, and to have reſolved in his heart never to curſe the ground for man's ſake, but to continue the viciſſitudes of ſummer, and winter, day, and night, *&c.* as long as the earth ſhall remain. And among the philoſophers themſelves, the truth we are now manifeſting, has not been altogether ignored. For though *Seneca* ſomewhere, more wittily than truly, ſays, *Non cauſa mundo ſumus hyemem æſtatemque referendi*; *ſuas iſta leges habent*, *quibus divina exercentur. Nimis nos ſuſpicimus*, *ſi digni nobis videmur*, *propter quos tanta moveantur:* 'We are not the cauſe of the ſeaſons and returns of ſummer and winter to the world: theſe have their own laws, accommodated to the exerciſe of divine beings. We arrogate too much honour to our ſelves, if we eſteem our ſelves worthy, that ſuch vaſt bodies ſhould fulfil ſuch motions for our ſakes.' Yet *Lactantius* (not to mention other authors) tells us, that the *Stoicks generally believed the world to have been made for man. Vera eſt* (ſays he) *ſententia Stoicorum*, *qui aiunt noſtra cauſa mundum fuiſſe conſtructum. Omnia enim*, *quibus conſtat*, *quæque generat ex ſe mundus*, *ad utilitatem hominis accommodata ſunt:* 'True is the opinion of the Stoicks, that ſay, how that for our ſakes the world was made; for all things, that are, and that the world doth by itſelf generate, are accommodated to the advantage of man.' And *Seneca* himſelf ſpeaks elſewhere almoſt as if he had read and believed the beginning of *Geneſis: Dii* (ſays he) *non per negligentiam nos genuere*, *quibus tam multa genuerant: cogitavit enim nos ante natura*, *quam fecit:* 'The gods were not careleſs or unconcerned in the making of man, for whom they made ſo many other creatures: for nature deſigned us, and drew us out in idea, before ſhe made us.'

Secundo De Nat. Deor.

Nor were the Stoicks the only philoſophers, to whom the contemplation of the univerſe diſcovered this end of it. For to inſtance now in *Cicero* only; *Quorum igitur cauſâ* (ſays that great orator) *effectum eſſe mundum? Eorum ſcilicet animantium*, *quæ ratione utuntur: hi ſunt dii & homines*, *quibus profecto nihil eſt melius*; 'And for whoſe ſake then was the world made? for thoſe beings, that have reaſon and intelligence, *viz.* gods and men, than whom, no being is more excellent.'

Having thus premiſed, *Pyrophilus*, that two of God's principal aims in the creation were the manifeſtation of his own glorious attributes, and the welfare of his nobleſt viſible creature, man; it will not be perhaps difficult for you to diſcern, that thoſe, who labour to deter men from ſedulous enquiries into nature, do (though, I grant, deſignleſly) take a courſe, which tends to defeat God of both thoſe mentioned ends.

That accommodation and delight, which the creatures might afford man, is much im-

For to ſpeak, firſt, to the laſt of them, that man's external fruition of the creatures, and the delight and accommodation which they may afford him, muſt be highly prejudiced and impaired by his ignorance of that natural philoſophy, wherein his dominion over the creatures chiefly conſiſts, what we ſhall ſay hereafter concerning the uſefulneſs of the knowledge of nature to human life, will ſufficiently evince. But ſuch an animal fruition paired by the want of natural philoſophy.

fruition (if I may ſo call it) of the works of nature affords not man all the good, that God deſigned him in them. For religion being, not only the great duty of man, but the grand inſtrument of his future happineſs, which conſiſts in an union with, and fruition of God, during that endleſs term, that ſhall ſucceed the expiration of his tranſitory life on earth; whatever increaſes or cheriſhes his religion, deſerves to be looked on as a great contributer to his happineſs. And we may therefore venture to affirm, that the knowledge of the creatures does leſs advantage man, as it enables him to maſter them, than as it aſſiſts him, by admiring and ſerving him, to become acceptable to their author. And whatever our diſtruſtful adverſaries are pleaſed to ſurmiſe to the contrary, certainly God intended, that his creatures ſhould afford not only neceſſaries and accommodations to our animal part, but inſtructions to our intellectual. The world is wont to be ſtyled not unfitly by divines, the Chriſtian's inn; but perchance it may be altogether as properly called his ſhip: for whereas both appellations ſuppoſe him a traveller, the inn, though it refreſh him in his journey, does not further him in it, but rather retard his progreſs, by detaining him in one place; whereas a ſhip, not only ſerves the paſſenger for an inn when he is weary, but helps to convey him towards his journey's end. And according to this notion, to ſuppoſe, that God hath placed in the world innumerable things to feed man, and delight him, and none to inſtruct him, were a conceit little leſs injurious to God, than it were to a wiſe merchant, that ſends perſons he loves to a far country, to think, that he would furniſh their cabinets with plenty of proviſions, ſoft beds, fine pictures, and all other accommodations for their voyage, but ſend them to ſea diſprovided of ſea-charts, and mariner's compaſſes, and other requiſite helps to ſteer their courſe by to the deſired harbour.

That the inſtructions to our intellectual part are more conſiderable, than the accommodations we have from nature to our animal part.

AND indeed ſo far is God from being unwilling, that we ſhould pry into his works, that by divers diſpenſations he impoſes on us, little leſs than a neceſſity of ſtudying them. For firſt he begins the book of ſcripture with the deſcription of the book of nature, of which he not only gives us a general account, to inform us, that he made the world (ſince for that end, the very firſt verſe in the bible might have ſufficed) but he vouchſafes us by retail the narrative of each day's proceedings; and in the two firſt chapters of *Geneſis*, is pleaſed to give nobler hints of natural philoſophy than men are yet perhaps aware of. Though, that in moſt other places of the ſcripture, where the works of nature are mentioned but incidently, or in order to other purpoſes, they are ſpoken of rather in a popular than accurate manner, I dare not peremptorily deny, being unwilling to intereſt the reputation of Holy Writ (deſigned to teach us rather divinity than philoſophy) in the doubtful contentions of naturaliſts, about ſuch matters, as may (though the hiſtory of the creation cannot) be known by the meer light of natural reaſon. We may next obſerve, that God has made ſome knowledge of his created book, both conducive to the belief, and neceſſary to the underſtanding of his written one; our Saviour making it one cauſe of the Sadducees great error about the reſurrection, that they *knew not the power of God*. And the Scripture being ſo full of alluſions to, and compariſons borrowed from the properties of the creatures, that there are many texts not clearly intelligible without ſome knowledge of them; as may appear even by the firſt Goſpel (the promiſe *that the ſeed of the woman ſhould bruiſe the ſerpent's head, and have his heel bruiſed by that ſubtle creature*) preached to fallen man in *Paradiſe*, and by the repreſentation of the world's four great monarchies, and the genius of each of them under the notion of four beaſts, in *Daniel*'s prophetick viſion: and that often repeated precept of our great Maſter to his diſciples is couched in an expreſſion alluding to the properties of animals. For where he commands them to be wiſe as ſerpents, and harmleſs as doves, he does not only recommend to them a ſerpentine warineſs in declining dangers, but ſeems alſo to preſcribe not alone an inoffenſiveneſs towards others

Of the hints of natural philoſophy in the hiſtory of the creation, and other references to it in other places, 30, 31.

(the conſpicuouſneſs of which quality in pigeons hath made them, though erroneouſly, be ſuppoſed to have no gall,) but alſo as harmleſs a way of eſcaping the dangers they are actually ingaged in, as that of doves, who being purſued by birds of prey, endeavour to ſave themſelves not by fight, but only by flight.

AND indeed ſo many of the texts in Scripture are not to be competently illuſtrated, without ſome knowledge of the properties of the creatures related to in them, that I wonder not that *Levinus Lemnius*, *Frantzius*, *Ruæus*, and other learned men have thought it requiſite to publiſh entire treatiſes, ſome of the animals, others of the ſtones, and others of the works of nature mentioned in Scripture. Only I could wiſh, that they had been as wary in their writings as commendable for their intentions, and had not ſometimes admitted doubtful or fabulous accounts into comments upon that book, whoſe prerogative it is to teach nothing but truth.

NOR ought their labours to deter others from cultivating the ſame theme, for as (ſuch is God's condeſcenſion to human weakneſs) moſt of the texts, to whoſe expoſition phyſiology is neceſſary, may be explicated by the knowledge of the external, or at leaſt more eaſily obſerved qualities of the creatures; ſo, that there are divers not to be fully underſtood without the aſſiſtance of more penetrating indagations of the abſtruſities of nature, and the more unobvious properties of things, an intelligent and philoſophical peruſer will readily diſcern.

NOW if you ſhould put me upon telling you, *Pyrophilus*, what thoſe attributes of God are, which I ſo often mention to be viſibly diſplayed in the fabrick of the world, I can readily anſwer you, that though many of God's attributes are legible in his creatures, yet thoſe, that are moſt conſpicuous there, are his power, his wiſdom, and his goodneſs, in which the world, as well as the bible, though in a differing, and in ſome points a darker way, is deſigned to inſtruct us; which, that you may not think to be affirmed gratis, we muſt inſiſt a while on each of the three.

**How God's power is conſpicuous in the creatures, 32, 33, 34.**

AND firſt, how boundleſs a power, or rather what an almightineſs is eminently diſplayed in God's making out of nothing all things, and without materials or inſtruments conſtructing this immenſe fabrick of the world, whoſe vaſtneſs is ſuch, that even what may be proved of it, can ſcarcely be conceived, and after a mathematical demonſtration its greatneſs is diſtruſted! which yet is, I confeſs, a wonder leſs to be admired, than the power expreſſed by God in ſo immenſe a work, which nevertheleſs ſome modern philoſophers (whoſe opinions I find ſome cabaliſts to countenance) ſuppoſe to be not the only production of God's omnipotence. Not to mention elephants, or whales, ſome of which an hyperboliſt would not ſcruple to call moving mountains, and floating iſlands; and to paſs by thoſe ſtupendous hills, and thoſe ſeas, where the light loſes it ſelf, as objects, which their nearneſs only repreſents ſo bulky; let us haſten to conſider, that whereas the terreſtrial globe we men inhabit, contains, beſides all thoſe vaſt kingdoms, the union of ſome of which conſtituted the world's four celebrated monarchies, thoſe ſpacious (ſince detected) American regions, that have been deſervedly ſtyled the new world; and that whereas the common account makes the circuit of this terreſtrial globe to be no leſs than 22600 *Italian* miles, conſiſting each of 1000 geometrical paces, (which number the more recent account of the accurate *Gaſſendus* makes amount to 26255 miles of the ſame meaſure;) whereas, I ſay, this globe of earth and water ſeems to us ſo vaſt, aſtronomers teach us, that it is but a point in compariſon of the immenſity of heaven; which they not irrationally prove by the parallaxis (or circular difference betwixt the place of a ſtar, ſuppoſed to be taken by two obſervations, the one made at the centre, and the other on the ſurface of the earth) which *Gaſſendus* confeſſeth to be undiſcernible in the fixt ſtars; as if the terreſtrial globe were ſo mere a point, that it were not material, whether a fixt ſtar be looked upon from the centre, or from the ſurface of the earth. This may leſſen our wonder at the Ptolemæans making the ſun (which ſeems not half a foot over) to be above a hundred ſixty and ſix times bigger than the earth, and diſtant from it one thouſand one hundred ſixty and five ſemi-diameters of the earth, each of which contains, according to the aforementioned computation of *Gaſſendus*, 4177 miles; and at their ſuppoſing the fixt ſtars (whoſe diſtance the ſame author, as a Ptolemæan, ſupputes to be 19000 ſemi-diameters of the earth) ſo great, that they conclude each of the fixed or ſmalleſt magnitude to be no leſs than 18 times greater than the whole earth, and each ſtar of the firſt or chief magnitude to exceed the terreſtrial globe 108 times. And as for the Copernicans (that growing ſect of aſtronomers) they, as their hypotheſis requires, ſuppoſe the vaſtneſs of the firmament to be exceedingly greater, than the ancients believed it. For *Philippus Lanſbergius*, who ventured to aſſign diſtances and dimenſions to the planets and fixed ſtars (which *Copernicus* forbore to do) ſuppoſes as well as his maſter, that the great orb it ſelf (as the Corpernicans call that, in which they eſteem the earth to move about the ſun) though its ſemi-diameter be ſuppoſed to be 1500 times as great as that of the earth, is but as a point in compariſon of the firmament or ſphere of the fixed ſtars; which he ſuppoſes to be diſtant from the earth, no leſs than 28,000 ſemi-diameters of the great orb, that is, 42,000,000 of ſemi-diameters of the earth; or, according to the former computation of common miles, 175,434,000,000, which is a diſtance vaſtly exceeding that, which the Ptolemæans ventured to aſſign, and ſuch as even imagination it ſelf can hardly reach to. I confeſs indeed, that I am not ſo well ſatisfied with the exactneſs (nor perhaps with the grounds) of theſe kinds of computations, by reaſon of the difficulty I have met with in making exact celeſtial obſervations with either teleſcopes, or other inſtruments, ſufficiently witneſſed, by the great diſparity remarkable betwixt the computations of the beſt artiſts themſelves. But on the other ſide I am not ſure, but that even the Copernicans aſcribe not too great a diſtance to ſome of the fixed ſtars; ſince (for aught we yet know) thoſe of the ſixth magnitude, and thoſe, which our teleſcopes diſcover (though our bare eyes cannot) are not really leſs than thoſe of the firſt magnitude, but only appear ſo by reaſon of their greater diſtance from our eyes: as ſome fixed ſtars ſeem no bigger than *Venus* and *Mercury*, which are much leſſer than the earth. And therefore upon ſuch conſiderations, and becauſe the modeſteſt computation allows the firmament to be great enough to make the earth but a point in compariſon of it; it will be ſafe enough, as well as juſt, to conclude with the Pſalmiſt, *Great is the Lord, and greatly to be praiſed; and his greatneſs is unſearchable.*

*Gaſſend.* Inſt. Aſtr. l. 2. c. 13.

*Gaſſendi* lib. 3. cap. 11.

How God's wiſdom is conſpicuous in them.

THE next attribute of God, that ſhines forth in his creatures, is his wiſdom; which to an intelligent conſiderer appears very manifeſtly expreſſed in the world, whether you contemplate it as an aggregate or ſyſtem of all natural bodies, or conſider the creatures it is made up of, both in their particular and diſtinct natures, and in relation to each other, and the univerſe, which they conſtitute. In ſome of theſe the wiſdom of God is ſo conſpicuous, and written in ſuch large characters, that it is legible even to a vulgar reader: but in many others the lineaments and traces of it are ſo delicate and ſlender, or ſo wrapt up and covered with corporeity, that it requires an attentive and intelligent peruſer. So numberleſs a multitude, and ſo great a variety of birds, beaſts, fiſhes, reptiles, herbs, ſhrubs, trees, ſtones, metals, minerals, ſtars, &c. and every one of them plentifully furniſhed and endowed with all the qualifications requiſite to the attainment of the reſpective ends of its creation, are productions of a wiſdom too limitleſs not to be peculiar to God: to inſiſt on any one of them in particular (beſides that it would too much ſwell this diſcourſe) might appear injurious to the reſt; which do all of them deſerve that extenſive exclamation of the Pſalmiſt, *How manifold are thy works, O Lord; in wiſdom haſt thou made them all.* And therefore I ſhall content myſelf to

*Pſal.* civ. 24.

obſerve in general, that, as highly as ſome naturaliſts are pleaſed to value their own knowledge, it can at beſt attain but to underſtand and applaud, not emulate the productions of God. For as a novice, when the curiouſeſt watch the rareſt artiſt can make, is taken in pieces and ſet before him, may eaſily enough diſcern the workmanſhip and contrivance of it to be excellent; but had he not been ſhewn it, could never have of himſelf deviſed ſo ſkilful and rare a piece of work; ſo, for inſtance, an anatomiſt, though when by many and dextrous diſſections of human bodies, and by the help of mechanical principles and rules (without a competent ſkill wherein, a man can ſcarce be an accompliſhed and philoſophical anatomiſt) he has learned the ſtructure, uſe, and harmony of the parts of the body, he is able to diſcern that matchleſs engine to be admirably contrived, in order to the exerciſe of all the motions and functions, whereto it was deſigned: and yet this artiſt, had he never contemplated a humane body, could never have imagined or deviſed an engine of no greater bulk, any thing near ſo fitted to perform all that variety of actions we daily ſee performed either in or by a human body. Thus the circular motion of the blood, and ſtructure of the valves of the heart and veins (the conſideration whereof, as himſelf told me, firſt hinted the circulation to our famous *Harvey)* though now modern experiments have for the main (the modus ſeeming not yet ſo fully explicated) convinced us of them, we acknowledge them to be very expedient, and can admire God's wiſdom in contriving them: yet thoſe many learned anatomiſts, that have for many ſucceeding ages preceded both Dr. *Harvey* and *Columbus*, *Ceſalpinus*, *Padre Paulo*, and Mr. *Warner*, (for each of theſe four laſt are ſuppoſed by ſome to have had ſome notion of the circulation) by all their diligent contemplation of human bodies, never dreamed (for aught appears) of ſo advantageous an uſe of the valves of the heart, nor that nimble circular motion of the blood, of which our modern circulators think they diſcern ſuch excellent uſe, not to ſay, neceſſity.

Particular obſervations of the ſtructure of human bodies.

*Prov.* xiii. 19, 20.

AND though it be true, that the greater works of God do as well declare his great wiſdom as his power, according to that of the inſpired philoſopher; *The Lord by wiſdom hath founded the earth, by underſtanding hath he eſtabliſhed the heavens. By his knowledge the depths are broken up, and the clouds drop down the dew*; yet does not his wiſdom appear leſs in leſſer creatures; for there is none of them ſo little, but it would deſerve a great deal of our wonder, did we attentively enough conſider it. And as *Apelles* (in the ſtory) was diſcovered by the ſkilful *Protagoras*, by ſo neat and ſlender a line, that *Protagoras*, by being ſcarce able to diſcern it, diſcerned it to have been drawn by *Apelles:* ſo God, in theſe little creatures, oftentimes draws traces of omniſcience, too delicate to be liable to be aſcribed to any other cauſe. I have ſeen elephants, and admired them leſs than the ſtructure of a diſſected mole, which hath better eyes than thoſe, that will not ſee a deſignation in the dimneſs of its eyes (made only to ſee the light, not other objects by the help of it) and the unwonted poſture of its feet, given it not to run on the ground, but to dig it ſelf a way under ground. And, as deſpicable as their littleneſs makes the vulgar apt to think ſome creatures, I muſt confeſs my wonder dwells not ſo much on nature's clocks (if I may ſo ſpeak) as on her watches, and is more exerciſed in the coyneſs of the ſenſitive plant, and the magnetical properties of a ſmall and abject loadſtone, than the bulk of the talleſt oaks, or thoſe vaſt rocks, made famous by ſhipwrecks. I have paſſed the *Alps*, and have ſeen as much to admire at in an ant-hill; and have ſo much wondered at the induſtry of thoſe little creatures themſelves, that inhabited it, that I have ceaſed to wonder at their having given a theme to *Solomon*'s contemplation. Thoſe vaſt exotick animals, which the multitude flocks to ſee, and which men give money to be allowed to gaze on, have had many of them leſs of my admiration than the little caterpillar, (as learned naturaliſts eſteem it) to which we are beholden for ſilk. For (not to mention all the obſervables crouded by nature

Of the eyes and feet of moles.

Of the ſilk-worm.

in that little worm) I thought it very well deſerved my wonder (when not long ſince I kept ſome of them purpoſely to try experiments) how this curious ſpinſter, after he had buried himſelf alive in the precious tomb he had wrought for himſelf out of his own bowels, did caſt off his former ſkin and legs, and, in ſhew, his former nature, appearing for divers days but an almoſt moveleſs maggot; till at length, diveſting this ſecond tegument alſo (in which neſt, phœnix-like, he had been regenerated out of his own remains) he came forth (if I may ſo ſpeak) out of his attiring room under another form, with wings, eyes, and legs, *&c.* to act a new part upon the ſtage of the world; which having ſpent ſome days, without feeding (that I could obſerve) in providing for the propagation of his ſpecies, he forſakes and dies. And I the rather mention the ſilk-worm, becauſe that there have been of late divers ſubtle ſpeculators, who would fain perſuade us, that animals do nothing out of inſtinct, or, if you pleaſe, innate or ſeminal impreſſions; but ſpin, build neſts, and perform all the other actions, for which they are admired, barely by imitation of what they have ſeen done by others of the ſame kind. But in the ſilk-worm (at leaſt here in *England*) this plauſible opinion will not hold: for the ſilk-worms I kept, were not hatched but in the ſpring, out of eggs laid ſome days in the ſun; and the worms, that laid thoſe eggs, being every one of them dead the winter before, it was impoſſible theſe new ſilk-worms, when they firſt began to ſpin their ſcarce imaginable fine web, and incloſe themſelves in oval balls of a very artificial figure and texture, ſhould have wrought thus by imitation; there not having been for many months before, in the place, where they were hatched (nor perhaps in the whole country) any ſilk-worms alive which they might imitate. But I muſt leave theſe curious ſpinſters to their work, and proceed to tell you, that ſeas and mountains, with the other hyperboles of nature (if I may ſo term them) proclaim indeed God's power, but do not perhaps more manifeſt his wiſdom, than the contrivance of ſome living engines, and (if I may ſo call them) breathing atoms, that are ſo ſmall, that they are almoſt all workmanſhip; ſo that, as before, in the Pſalmiſt's expreſſion we truly ſaid of God's greatneſs, *That it was unſearchable*; we may now as truly ſay of his wiſdom in the prophet's words, and in the ſame text where he repreſents him as the Creator of the ends of the earth, *That there is no ſearching of his underſtanding.*

That it works by inſtinct, and not by imitation.

*Iſa.* xl. 28.

And if I durſt, *Pyrophilus*, make this part of this eſſay of a length too diſproportionate to the reſt, I could eaſily, as well as willingly, repreſent to you divers things, which might ſerve to illuſtrate the πολυποικίλος σοφία τȣ̃ Θεȣ̃, *manifold wiſdom of God* (as St. *Paul* ſpeaks on another occaſion:) but though I dare not expatiate on this ſubject, yet neither dare I altogether conceal from you, that I have ſometimes admired to ſee, what ſcarce imaginable variety of living engines his plaſtick ſkill (if I may ſo ſpeak) has been able to produce, (eſpecially in the waters) without ſcarce any other reſemblance betwixt them, than that they are each of them excellent in its own kind, and compleatly furniſhed according to the exigency of its nature. And that, which much encreaſes this wonder, is the diſproportion of thoſe living engines, wherein the great [*Yotzêer hakkôl*] *Former of all things* (as the Scripture juſtly calls God) has been pleaſed to diſplay an almoſt equally ſkilful contrivance. Amongſt terreſtrial animals we have the elephant, of whoſe ſtupendous vaſtneſs ſuch ſtrange things are related, even by eminent writers, that I know not well how either to diſ-believe them, or give credit to them: and therefore we ſhall content our ſelves to mention that, which is left on record by the accurate *Gaſſendus* in the life of *Peireſkius.* For this matchleſs gentleman having cauſed an elephant, in the year 1631, to be weighed in a ſcale, purpoſely provided, he was found to weigh, of the Roman pounds (conſiſting of twelve ounces a-piece) very near five thouſand. And yet ſurely that this elephant was very far from being one of the largeſt of that ſort of beaſts, he, that ſhall conſider the bigneſs and length of

*Eph.* iii. 10.

*Jer.* x. 16.

*Gaſſend.* in Vit. *Peireſkii*, lib. 4.

Of the vaſtneſs of the elephant, and its diſproportion to the ἀκαρὶ and ſuch like mites.

ſome

Particular obſervations of the ſtructure of human bodies.

obſerve in general, that, as highly as ſome naturaliſts are pleaſed to value their own knowledge, it can at beſt attain but to underſtand and applaud, not emulate the productions of God. For as a novice, when the curiouſeſt watch the rareſt artiſt can make, is taken in pieces and ſet before him, may eaſily enough diſcern the workmanſhip and contrivance of it to be excellent; but had he not been ſhewn it, could never have of himſelf deviſed ſo ſkilful and rare a piece of work; ſo, for inſtance, an anatomiſt, though when by many and dextrous diſſections of human bodies, and by the help of mechanical principles and rules (without a competent ſkill wherein, a man can ſcarce be an accompliſhed and philoſophical anatomiſt) he has learned the ſtructure, uſe, and harmony of the parts of the body, he is able to diſcern that matchleſs engine to be admirably contrived, in order to the exerciſe of all the motions and functions, whereto it was deſigned: and yet this artiſt, had he never contemplated a humane body, could never have imagined or deviſed an engine of no greater bulk, any thing near ſo fitted to perform all that variety of actions we daily ſee performed either in or by a human body. Thus the circular motion of the blood, and ſtructure of the valves of the heart and veins (the conſideration whereof, as himſelf told me, firſt hinted the circulation to our famous *Harvey)* though now modern experiments have for the main (the modus ſeeming not yet ſo fully explicated) convinced us of them, we acknowledge them to be very expedient, and can admire God's wiſdom in contriving them: yet thoſe many learned anatomiſts, that have for many ſucceeding ages preceded both Dr. *Harvey* and *Columbus*, *Ceſalpinus*, *Padre Paulo*, and Mr. *Warner*, (for each of theſe four laſt are ſuppoſed by ſome to have had ſome notion of the circulation) by all their diligent contemplation of human bodies, never dreamed (for aught appears) of ſo advantageous an uſe of the valves of the heart, nor that nimble circular motion of the blood, of which our modern circulators think they diſcern ſuch excellent uſe, not to ſay, neceſſity.

*Prov.* xiii. 19, 20.

Of the eyes and feet of moles.

Of the ſilk-worm.

AND though it be true, that the greater works of God do as well declare his great wiſdom as his power, according to that of the inſpired philoſopher; *The Lord by wiſdom hath founded the earth, by underſtanding hath he eſtabliſhed the heavens. By his knowledge the depths are broken up, and the clouds drop down the dew*; yet does not his wiſdom appear leſs in leſſer creatures; for there is none of them ſo little, but it would deſerve a great deal of our wonder, did we attentively enough conſider it. And as *Apelles* (in the ſtory) was diſcovered by the ſkilful *Protagoras*, by ſo neat and ſlender a line, that *Protagoras*, by being ſcarce able to diſcern it, diſcerned it to have been drawn by *Apelles:* ſo God, in theſe little creatures, oftentimes draws traces of omniſcience, too delicate to be liable to be aſcribed to any other cauſe. I have ſeen elephants, and admired them leſs than the ſtructure of a diſſected mole, which hath better eyes than thoſe, that will not ſee a deſignation in the dimneſs of its eyes (made only to ſee the light, not other objects by the help of it) and the unwonted poſture of its feet, given it not to run on the ground, but to dig it ſelf a way under ground. And, as deſpicable as their littleneſs makes the vulgar apt to think ſome creatures, I muſt confeſs my wonder dwells not ſo much on nature's clocks (if I may ſo ſpeak) as on her watches, and is more exerciſed in the coyneſs of the ſenſitive plant, and the magnetical properties of a ſmall and abject loadſtone, than the bulk of the talleſt oaks, or thoſe vaſt rocks, made famous by ſhipwrecks. I have paſſed the *Alps*, and have ſeen as much to admire at in an ant-hill; and have ſo much wondered at the induſtry of thoſe little creatures themſelves, that inhabited it, that I have ceaſed to wonder at their having given a theme to *Solomon*'s contemplation. Thoſe vaſt exotick animals, which the multitude flocks to ſee, and which men give money to be allowed to gaze on, have had many of them leſs of my admiration than the little caterpillar, (as learned naturaliſts eſteem it) to which we are beholden for ſilk. For (not to mention all the obſervables crouded by nature in that little worm) I thought it very well deſerved my wonder (when not long ſince I kept ſome of them purpoſely to try experiments) how this curious ſpinſter, after he had buried himſelf alive in the precious tomb he had wrought for himſelf out of his own bowels, did caſt off his former ſkin and legs, and, in ſhew, his former nature, appearing for divers days but an almoſt moveleſs maggot; till at length, diveſting this ſecond tegument alſo (in which neſt, phœnix-like, he had been regenerated out of his own remains) he came forth (if I may ſo ſpeak) out of his attiring room under another form, with wings, eyes, and legs, *&c.* to act a new part upon the ſtage of the world; which having ſpent ſome days, without feeding (that I could obſerve) in providing for the propagation of his ſpecies, he forſakes and dies. And I the rather mention the ſilk-worm, becauſe that there have been of late divers ſubtle ſpeculators, who would fain perſuade us, that animals do nothing out of inſtinct, or, if you pleaſe, innate or ſeminal impreſſions; but ſpin, build neſts, and perform all the other actions, for which they are admired, barely by imitation of what they have ſeen done by others of the ſame kind. But in the ſilk-worm (at leaſt here in *England*) this plauſible opinion will not hold: for the ſilk-worms I kept, were not hatched but in the ſpring, out of eggs laid ſome days in the ſun; and the worms, that laid thoſe eggs, being every one of them dead the winter before, it was impoſſible theſe new ſilk-worms, when they firſt began to ſpin their ſcarce imaginable fine web, and incloſe themſelves in oval balls of a very artificial figure and texture, ſhould have wrought thus by imitation; there not having been for many months before, in the place, where they were hatched (nor perhaps in the whole country) any ſilk-worms alive which they might imitate. But I muſt leave theſe curious ſpinſters to their work, and proceed to tell you, that ſeas and mountains, with the other hyperboles of nature (if I may ſo term them) proclaim indeed God's power, but do not perhaps more manifeſt his wiſdom, than the contrivance of ſome living engines, and (if I may ſo call them) breathing atoms, that are ſo ſmall, that they are almoſt all workmanſhip; ſo that, as before, in the Pſalmiſt's expreſſion we truly ſaid of God's greatneſs, *That it was unſearchable*; we may now as truly ſay of his wiſdom in the prophet's words, and in the ſame text where he repreſents him as the Creator of the ends of the earth, *That there is no ſearching of his underſtanding.*

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ſome of their teeth, as they are commonly called, which are to be ſeen at divers places, both in *England* and elſewhere, and is not reſolved not to believe the conſonant relations of Eaſtern travellers (among whom *Linſcoten* tells us, there have been ſome teeth found to weigh two hundred pounds a-piece, each pound conſiſting of twenty-four ounces) may be eaſily perſuaded. On the other ſide, let us reflect upon the ſmallneſs of ſome terreſtrial animals; and not to mention that little white creature bred in wax, which *Ariſtotle* calls 'Ακαρὶ, and ſpeaks of as ſuppoſed to be the leaſt of all living creatures whatſoever; let us conſider thoſe little mites, that are bred in mouldy cheeſe; for divers of theſe ſcarce amount to the weight of a grain, and every pound containing five thouſand ſeven hundred and ſixty grains; ſuppoſing each mite did weigh a whole grain, yet that formerly mentioned ſmall elephant would exceed him near 28,800,000 times. And yet though a mite ſeem but a moving atom, and, unleſs there be divers together, is not eaſily diſcerned by the unaſſiſted eye; yet in an excellent microſcope, I have, you know, ſeveral times both ſeen and ſhewn to others, even in a gloomy day, and a diſadvantageous place, not only the limbs of this little animal, but the very hair growing upon his legs. Now let us but conſider, how ſtrangely ſkilful and delicate a workmanſhip muſt be employed to contrive into ſo narrow a compaſs the ſeveral parts internal and external, requiſite to make up this little animal; how many muſt go to the texture of the eyes, and other organs of ſenſe; how many to the ſnout (which he has, not unlike a hog) and the ſeveral parts of it; how many to the ſtomach and guts, and the other inward parts addicted to the digeſtion of aliment, and excluſion of excrements; and, to be ſhort, how unimaginably ſubtle muſt be the animal ſpirits running to and fro in nerves ſuitable in ſuch little legs: and if, as we have obſerved them to multiply by eggs, the little creatures be hatched in thoſe little eggs, after the manner of divers other oviparous animals, how much ſmaller than a hatched mite muſt be a mite upon the animation of its delineated parts? ſince in hen's eggs we have ſometimes ſeen the chick manifeſtly alive, and its limbs clearly delineated, whilſt yet it took up ſo ſmall a portion of the egg, that both the white and the yolk (betwixt which it is generated, and not of the chalaza or treadle, as *Aquapendente* and other moderns teach) ſeemed to be ſometimes yet intire, as well as involved in their peculiar membranes. But it is not ſo conſpicuous in gradient animals (if I may ſo ſpeak) as in ſwimming ones; how vaſtly diſproportionate maſſes of matter the wiſe Former of all things can faſhion into living engines. For whales are much more ſtupendous creatures than elephants: And not to mention what *Hartenius (apud Johnſtonum)* tells us of twenty ſorts of whales, whereof the eighteenth ſpecies, which he calls *Nordhwal*, is by him related to be ninety ells long; but what ells he means, I know not: nor to mention thoſe leſs incredible accounts, which are given of the vaſtneſs of whales by our Engliſh navigators, who are wont to fiſh for them; I ſhall only ſet down what is related by one of the eminenteſt modern Lyncean philoſophers*, becauſe he ſpeaks as an eye-witneſs when he tells us, that in the year 1624, there was caſt upon a place near *Santa Severa*, about 30 miles from *Rome*, a dead whale of 91 palms in length, and 50 in thickneſs: he adds, that its mouth was 16 palms long, and ten high; in which, being opened and kept gaping, a man on horſe-back might find competent room; this mouth being uſed to harbour a tongue of twenty palms (which may make out fifteen foot) in length. The ſame inquiſitive writer adds, that four years before, near the iſland of *Corſica*, not far from the coaſt of *Italy*, another whale was caſt, one hundred foot long, which being a female, was found to be big with a cub of thirty foot long, 1500 pound weight. But that, which will let you ſee, *Pyrophilus*, the diſproportion betwixt theſe kind of fiſhes and common elephants, is that, which the ſame author adds, *that the lard only, or fat*, (as he ſpeaks, *carnea pinguedo) of this corpulent creature, weighed one hundred and*

*thirty-*

* *Jo. Faber. Lynceus* in his expoſition of ſome paſſages of p. 568.

Of the vaſtneſs of the whale, and its diſproportion to the ſmall worms or fiſhes lately diſcovered in vinegar.

*thirty-five thouſand pound*; that is, above twenty-ſeven times the weight of the whole elephant, which was cauſed to be weighed by *Peireſkius*. And though the omnipotent Creator ~~be able~~ to make ſwimming creatures of ſuch prodigious bigneſs, that the ocean itſelf may ſeem to be but a proportionate pond for ſuch fiſhes; yet is the ſame omniſcient continuer as able to make a ſwimming engine more ſlender than a cheeſe-mite, and ſo little, that the ſmall part of a grain may out-weigh divers of them. For, *Pyrophilus*, I muſt here acquaint you with a ſtrange obſervation, which I have been informed to have been ſome while ſince made in *Italy* by *Panarola* a famous phyſician in *Rome*, who is ſaid, by the help of an excellent microſcope, to have diſcerned in vinegar ſmall living creatures, which he takes to be worms. The mention of ſo unlikely an experiment made me ingage ſome excellent philoſophers and mathematicians to aſſiſt me in examining it: but though our microſcopes exceeded the beſt, that were brought us over from *Rome*, yet all our diligence and attention did but make them conclude, that *Panarola*'s eyes had been deluded. Notwithſtanding which, cauſing a ſomewhat hollow bottom of pure cryſtalline glaſs to be fitted to my microſcope, I proſecuted the enquiry myſelf; and at length was ſo lucky, as not only to diſcover theſe little creatures with a microſcope, but by holding the liquor in a chryſtal phial, almoſt upon the ſtrong flame of a candle, to diſcover multitudes of them with my naked eyes, as weak as they are. But though I have already convinced thoſe, that formerly derided ſuch obſervations, as not to be made with the beſt microſcope, yet the great weakneſs of my ſight has not permitted me to perfect my obſervations concerning theſe creatures. And therefore reſerving the more particular mention of this odd obſervation till another time, I ſhall now only tell you as much as is pertinent to our preſent purpoſe; namely, that having with a certain parcel of ſtrong white-wine vinegar (for it is not in every vinegar, that they are conſtantly to be found) filled up to the top thin phials, with long and ſlender necks; and having likewiſe with the ſame liquor filled other ſmall cryſtalline phials, though ſhort-necked, and held them betwixt my eye and the ſun, or a window open towards it, or very near a great candle, I have often in theſe glaſſes, eſpecially in their ſlender necks, after having a while fixed my eye on them, (attention being in this caſe very neceſſary) admiringly obſerved great numbers (and ſometimes as it were ſhoals) of living creatures, which ſeemed to be rather fiſhes than worms; for they ſwim freely up and down the liquor, and often hover about the top of it with a wriggling motion, like that of eels, to which likewiſe their long and ſlender ſhape reſembles them. And though the ſwimming creatures be not all exactly of a ſize, yet ſome of them ſeemed ſlenderer than any ſort of living ones, that hath hitherto been taken notice of by the unaſſiſted eye. And I remember, that having looked in a good microſcope upon one of them, and a cheeſe-mite, much about the ſame time, the fiſh appeared ſo ſlender, that we judged it not much thicker than one of the legs of the mite: ſo that conſidering what a vaſt deal of matter the great Creator can manage and faſhion into a whale, and in how little room he can contrive all the parts requiſite to conſtitute a fiſh, we may juſtly ſay to him in the Pſalmiſt's language, ***there is none like unto thee (O Lord) neither are there any works like unto thy works.***

*Pſalm* lxxxvi. 8.

THE laſt of the three properties of God, which we mentioned him to have manifeſted in the creation, is his goodneſs; of which all his creatures do in their due meaſure partake, partly by their having a being vouchſafed them, and partly by their being preſerved in it, as long as their ſubordination to higher purpoſes, and to more powerful creatures do permit, by that ſupporting influence of God, which keeps them from relapſing into their firſt nothing; according to that memorable paſſage, where *Nehemiah* having mentioned God as the *Creator of the heavens, the earth, the ſeas, and all the creatures belonging to them*, he calls him the *Preſerver*, or (as the original has it)

How God's goodneſs is conſpicuous in his creatures by his proviſion of accommodations for them all, but eſpecially for his favourite, man.

*Nehem*. ix. 6.

Gen. viii. 1. *the Enlivener of them all.* And as for animals, who are more capable of enjoying, though not moſt of them of diſcerning his bounty, his goodneſs to them is more conſpicuous. For beſides that in ſcripture he is called the *Preſerver both of man and beaſt*, and accordingly is ſaid to *give food even to the young ravens that cry*, and to have, after the *flood*, remembered not only *Noah*, but *every living thing that was with him in the ark*; his goodneſs to them is apparent, by the plentiful and eaſily attainable proviſion he makes according to the exigence of their ſeveral natures, for that innumerable ſwarm of various birds, beaſts, fiſhes, reptiles, and other animals, that people the terreſtrial globe, and the contiguous parts of the world, and by his endowing each of them with all the qualifications requiſite to the perpetuation of their ſpecies, and the preſervation of their lives, as far forth as is conſiſtent with his ends in their creation. But moſt reſplendent does the goodneſs of God appear towards his favourite creature, man, whom having vouchſafed to ennoble with his own image, he makes moſt of the creatures of the world viſible to us, pay homage to him, and in ſome manner or degree do him ſervice; God's liberality at once beſtowing on him all thoſe creatures, by endowing him with a reaſon enabling him to make uſe of them; ſo that even thoſe creatures, which he is not able to ſubdue by power, he is able to make ſerviceable to him by his knowledge: as thoſe vaſt globes of light, which are ſo far above him, that their immenſity and brightneſs can ſcarce render them viſible to him, are by man's mathematicks forced to give him an account of all their motions, and waiting upon his dials keep time for him; and even the defects of ſuch works of nature are by man's ſkill made ſerviceable to him, as the eclipſes of the moon ſerve geographers notably in that difficult and uſeful work of finding longitudes. The ſtars ſerve for candles to give man light, and the celeſtial orbs are his candleſticks. He breathes the air, the fire warms him, and ſerves him not only in his kitchen, but to maſter moſt other bodies in his furnaces. The clouds water his land, the earth ſupports him and his buildings, the ſea and winds convey him and his floating houſes to the remoteſt parts of the world, and enable him to poſſeſs every where almoſt all that nature or art has provided for him any where. The earth produces him an innumerable multitude of beaſts to feed, clothe, and carry him; of flowers and jewels to delight and adorn him; of fruits, to ſuſtain and refreſh him; of ſtones and timber, to lodge him; of ſimples, to cure him; and in ſum, the whole ſublunary world is but his magazine. And it ſeems the grand buſineſs of reſtleſs nature ſo to conſtitute and manage his productions, as to furniſh him with neceſſaries, accommodations, and pleaſures.

OF ſuch a number of plants, animals, metals, minerals, *&c.* that people and enrich the terreſtrial globe, perhaps there is not any one, of which man might not make an excellent uſe, had he but an inſight into its nature; nor are the moſt abject and deſpicable therefore the leaſt uſeful. There is not any ſtone, no not the ſparkling diamond itſelf, to whom man is ſo much beholden, as he is to the dark and unpromiſing loadſtone; without which the new world probably had never been detected, and many regions of the old world would have little or no commerce with each other. Nor have the lion, the eagle, and the whale joined all together, (though reputed the chief of birds, beaſts, and fiſhes) been ſo ſerviceable to man, as that deſpicable inſect, the ſilk-worm. And if we impartially conſider the luciferouſneſs (if I may ſpeak in my Lord of *St. Alban*'s ſtyle) of the properties of things, and their medical virtues, we ſhall find, that we trample upon many things, for which we ſhould have cauſe to kneel, and offer God praiſes, if we knew all their qualities and uſes. But of this ſubject we may elſewhere purpoſely treat.

To which I muſt only add, *Pyrophilus*, that you will injure nature, if you ſuppoſe, either that all the concretes, endowed with excellent properties, have long ſince been notorious;

Of the unknown and new detectedproperties and virtues of divers concretes.

Of the *Peruvian* bark, commonlycalled the *Jeſuits* powder.

notorious; or that all the medicinal virtues of ſimples, commonly uſed, are already known; or that all thoſe concretes are deſtitute of conſiderable properties, to whom none have been yet aſcribed by eminent authors. For almoſt every day either diſcloſes new creatures, or makes new diſcoveries of the uſefulneſs of things; almoſt each of which hath yet a kind of *terra incognita*, or undetected part in it. How many new concretes, rich in medicinal virtues, does the new world preſent the inquiſitive phyſicians of the old? *Notatu dignum* (ſays the ingenious *Piſo*, in his new publiſhed *Medicina Braſilienſis*, lib. 1.) *quod eximiæ tot arbores, frutices, & innumeræ herbæ, figura, foliis, & fructibus à veteris orbis vegetabilibus, paucis exceptis, diſſimillimæ appareant. Inde de avibus, animantibus, & piſcibus deprehenditur, ut & inſectis alatis, atque alis deſtitutis, quæ ineffabili colorum pulchritudine & portentoſa multitudine generantur, partim nota nobis, partim incognita*: ‘It is obſervable, that ſo many excellent trees, ſhrubs, and an innumerable company of herbs, ſome few excepted, ſhould all appear ſo unlike the vegetables of the antiently known world, both in figure, leaf, and fruits: and the ſame obſervation is made of birds, beaſts and fiſhes; and of inſects both flying and creeping, which are monſtrouſly numerous, and of unſpeakable beauty in colour, ſome known to us, and ſome unknown.’ And of the known American ſimples, how many latent virtues does experience from time to time diſcover? And (to mention now no others) the febrifugal property of that Peruvian tree, called by the natives *Gannanaperide*, whoſe bark, called commonly *China febris*, has been at *Rome*, and freſhly alſo at *London*, found ſo wonderfully effectual againſt thoſe ſtubborn diſeaſes, quartan agues; and though a learned author endeavours to depreciate it, by alledging, that it is wont rather to ſuſpend the fits, than truly cure the diſeaſe, which after a while will return again; yet, beſides that it may be often very beneficial to a weakened patient to have his fits put off, the phyſician thereby alſo gaining opportunities to imploy ſtrengthening and preventing remedies; beſides this, I ſay, if you will credit that great perſon, Sir *Kenelm Digby*, it is rather the patient's or doctor's fault, than the medicine's, if the diſeaſe return. For having purpoſely conſulted him about this objection againſt the uſe of the *cortex febrifugus*, he ſolemnly aſſured me, that of betwixt twenty and thirty perſons, that he had himſelf cured of quartans by this remedy, not ſo many as two fell into a relapſe.

Of the uſe of *Parony-chia fol. rutaceo* in the king s-evil, and of divers other concretes obſervable for their unknown properties.

AND now I am upon the more freſhly diſcovered virtues of American drugs, I might acquaint you with the admirable properties, not only in diſeaſes, but even in wounds, of a certain mineral, which (though careful examination of it has not yet taught me, to what ſpecies of ſtones to reduce it) you cannot but have heard mentioned with wonder, under the name of Sir *Walter Raleigh*'s ſtone, which my father, ὁ μακαρίτης, enjoyed, and did ſtrange things with for many years, and by his will bequeathed (as the higheſt legacy he could leave him) to his deareſt friend, the moſt learned and famous Bp. *Uſher*, Primate of *Ireland*. But of this ſtone, the merit of the ſubject makes me reſerve what I have to ſay, to a diſcourſe, wherein I may be allowed to ſay more to it than now I dare: and therefore I ſhall proceed to tell you, that it is not in the ſimples of the new world only, that new medicinal properties may be diſcovered; for even thoſe which daily obtrude themſelves upon our carele ſs eyes, or are trampled under our regardleſs feet, may poſſeſs virtues, to which the major part of botaniſts are mere ſtrangers. To which purpoſe I remember, that I have often gathered a little ſhort-lived and deſpicable plant, (namely *Paronychia folio rutaceo*) with which alone (ſlightly infuſed in beer) I lately knew a young kinſman of Sir *Kenelm Digby*'s, in few days, and without pain, as both himſelf, his mother, and his phyſician aſſured me, cured of that ſtubborn and ſeldom vanquiſhed diſeaſe of the king's-evil, againſt which it doth wonders: and yet having conſulted not only ſome of the famouſeſt and recenteſt herbals, both Engliſh

and

and Latin, about this, but alſo enquired of two or three eminent herbariſts, I could find neither any ſuch virtue, nor almoſt any at all, aſcribed by authors to that excellent plant.

Of the uſe of divers noxious concretes, and that they contain their own antidotes.

AND whereas God's bounty to man in the creatures ſeems a little clouded and ſtreightened by his permitting ſome poiſonous plants and venomous animals to have a being in nature; to that it may be replied, firſt, that many poiſonous bodies contain their own antidotes; inſomuch that the diligent *Piſo*, who hath had great opportunities to examine the effects of both, ventures to ſay, treating of the poiſons and antidotes to be met with in *Braſil*, *Equidem vix dixeris, venena an Alexiteria plura ſint pronata.* And a little lower, *Sic folia, flores, & fructus herbarum Tangaraca & Juquerii, venena Braſiliæ facilè prima, propriam ſuam unaquæque radicem oppoſitum habet antidotum.* And a little after, *Barbari viperarum pinguedinem & capita, tum & integra inſecta, quæ vulnera intulerint, ex arte parata, audacter & felici cum ſucceſſu venenatis ictibus applicant; adeoque per ipſos effectus comprobare nituntur in omni veneno contineri ſuam antidotum:* 'You can ſcarce determine, whether in theſe countries there are found more poiſons or antidotes: the leaves, flowers, and fruits of the herbs Tangarack and Juquer, the two moſt potent venoms of *Braſil*, each of theſe hath its proper root for an oppoſite antidote. The Barbarians apply the fat and heads of vipers, and the whole bodies of thoſe inſects, prepared according to art, that ſtung or ſtuck any perſon, and that with boldneſs and happy ſucceſs, to the wounds made by them, and ſo by the effects do attempt to prove, that in every venom its own antidote is contained.' And next, that the noxiouſneſs of many (and therefore not improbably of all of them) is not ſo incorrigible, but that by man's art and chymical preparation, they may be made, not only innocent and harmleſs, but uſeful too. This truth, *Pyrophilus*, antimony and quickſilver, and ſome other noxious bodies (which men have learned to make medicinal) have already taught our modern phyſicians; who preſcribe, even in their diſpenſatories, divers medicines made out of thoſe churliſh minerals, to which in the enſuing diſcourſes you will find divers others (perhaps not inferiour) added. That opium is reckoned by phyſicians among poiſons, I need not tell you; and yet ſuch powerful remedies may be made with it for many deſperate caſes, eſpecially in hot countries, that the good it may do, ſo much exceeds the harm, that phyſicians would be ſorry there were none of it in the world. The oil of ſcorpions is not only antidotal againſt their ſtings, but is witneſſed by experience, to be very uſeful to bring away the deſcending ſtone of the kidneys, and to remedy divers other miſchiefs, beſides thoſe, that ſcorpions can do. And to theſe I ſhall need but to add one inſtance more, becauſe of the nobleneſs of that ſingle one, and that is the root *Mandihoca*, ſo common all over the *Weſt Indies*: for nature is ſo far from having been a ſtep-mother to man, in making that plant abound ſo much in thoſe countries, though in its crude ſimplicity (as the Helmontians ſpeak) it be confeſſedly a rank poiſon, that ſhe hath ſcarce in any one plant been ſo bountiful to the Americans. For by a ſlight and eaſy preparation, which we ſhall hereafter mention, it affords many populous nations almoſt all the bread they eat, and ſome of them a good part of their drink; the root freed by a ſtrong preſs from the noxious juice, and dried, affording them that Caſſavy meal, whereof they make their bread; which by the taſte and colour I could not diſcern to be other than good. Nor is this the only uſe this poiſonous plant affords them; for the above-commended *Piſo* gives us this ſhort, but comprehenſive character of it; *Ex Mandihoca radice maximo ſcatente veneno, optimum alimentum non ſolùm, ſed & antidotum concinnatur,* (lib. 3.) 'From the root Mandihoca, that abounds with a very potent poiſon, there is made not only excellent aliment, but even antidote too.' But concerning the uſe, that may be made of poiſonous creatures, we elſewhere profeſſedly diſcourſe; and ſhall therefore now

Of that excellent *Weſt-Indian* root *Mandihoca*.

now proceed to obſerve to you here, that I have not yet mentioned to you the inſtance which moſt manifeſts the greatneſs of the good, which God intended man in the creatures. For, not content to have provided him all, that was requiſite either to ſupport or accommodate him here, he hath been pleaſed to contrive the world ſo, that (if man be not wanting to himſelf) it may afford him not only neceſſaries and delights, but inſtructions too. For each page in the great volume of nature is full of real hieroglyphicks, where (by an inverted way of expreſſion) things ſtand for words, and their qualities for letters. The Pſalmiſt obſerves, *That the heavens declare the glory of God:* and, indeed, they celebrate his praiſes, though with a ſoundleſs voice, yet with ſo loud a one (and which gives us the moral of *Plato*'s exploded notion of the muſick of the ſpheres) to our intellectual ears, that he ſcruples not to affirm, that *there is no ſpeech nor language, where their voice is not heard,* (or as *Junius* and *Tremellius* render it, without violence to the Hebrew text, *there is no ſpeech nor words, yet without theſe their voice is underſtood) and that their line is gone throughout all the earth:* that is (as the learned *Diodati* expounds it) their writing in groſs and plain draughts, and their words to the end of the world; their language having ſo eſcaped the confuſion of tongues, that theſe natural and immortal preachers give all nations occaſion to ſay of them, as the aſſembly at pentecoſt did of the inſpired Apoſtles, *we do hear them ſpeak in our tongues the wonderful works of God.*

How we are by the creatures inſtructed to devotion.
*Pſal.* xix. 1.

*Acts* ii. 11.

NOR can we, without liſtening to theſe ſermons, derive the entire (perhaps not the chiefeſt) benefit deſigned us in the creatures. For ſure that God, who hath compoſed us both of body and ſoul, hath not confined the uſes of ſo many admirable creatures, and ſo much inimitable workmanſhip, to that ignoble part of man, which coupleth him to the beaſts, with the neglect of that diviner portion, which allies him to the angels; vouchſafing to the lord of the creatures, in the fruition of this his palace, no higher prerogative, than he is pleaſed to allow to the brutes, that ſerve but to complete the variety requiſite for its embelliſhment. Of this opinion I lately found that excellent writer, St. *Auſtin*, to have been before me: For, *Non debes uti oculis* (ſays he) *ut pecus, tantum ut videas, quæ addas ventri, non menti: utere, ut homo, intende cœlum, & intende facta, & quære factorem; aſpice quæ vides, & quære quem non vides, crede in eum quem non vides, propter iſta quæ vides. Nolite fieri ſicut equus & mulus, &c.* 'You ought 'not to uſe your eyes as a brute, only to take notice of proviſions for your belly, and 'not for your mind: uſe them as a man; pry up into heaven; ſee the things made, 'and enquire the Maker; look upon thoſe things you can ſee, and ſeek after him, 'whom you cannot ſee, and believe on him you cannot ſee, becauſe of thoſe things 'you ſee: and be not like the horſe and mule, *&c.*'

NOR can the creatures only inform man of God's being and attributes (as we have already ſeen) but alſo inſtruct him in his own duties; for we may ſay of the world, as St. *Auſtin* did of the ſacraments, that it is *verbum viſibile.* And certainly, God hath never ſo confined himſelf to inſtruct men by words or types, as not to reſerve himſelf the liberty of doing it by things: witneſs his appointing the rainbow to preach his goodneſs to all nations, and fortify the faith of mankind againſt the fear of a ſecond deluge. It is ſomething too high a ſaying for an heathen, that of *Plato*, where he teaches, *That the world is God's epiſtle, written to mankind.* For by *Solomon* God ſends the *ſluggard to ſchool to the ant*, to learn a provident induſtry. Chriſt commands his diſciples to *learn of ſerpents and pigeons* prudence and inoffenſiveneſs. The ſame divine teacher enjoins his apoſtles to *conſider the lillies*, or (as ſome would have it) the *tulips of the field*, and to learn thence that difficult virtue of a diſtruſtleſs reliance upon God. And St. *Paul* ſeems almoſt angry with the Corinthians, that their faith, in ſo abſtruſe myſteries as that of the reſurrection, was not informed and ſtrengthened, by conſidering the

D. Aug. Hom. 3.

1 *Cor.* xv. 36, 37.

the meliorating death of corn committed to the earth. And the royal poet learns humility, by the contemplation of the moſt elevated parts of nature; *When I conſider* (ſays he) *the heavens, the work of thy fingers, the moon and ſtars, which thou haſt ordained, what is man, that thou viſiteſt him?* Thus you may ſee, that God intended the world ſhould ſerve man, not only for a palace to live in, and to gaze on, but for a ſchool of virtue, to which his philanthropy reſerves ſuch ineſtimable rewards, that the creatures can on no account be ſo beneficial to man, as by promoting his piety; by a competent degree of which, God's goodneſs hath made no leſs than eternal felicity attainable.

*Pſal.* viii. 34.

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# ESSAY III.

## *Containing a Continuation of the former.*

That their opinion, who would deter men from the ſcrutiny of nature, tends to defeat God of much of that glory man ſhould aſcribe unto him.

HAVING thus, *Pyrophilus*, endeavoured to evince, that the opinion, that would deter men from the ſcrutiny of nature, is not a little prejudicial to man's intereſts, and does very much leſſen the advantages he may derive from the creatures, both in relation to his accommodation in this life, and his felicity in the next; let us proceed to conſider, whether the doctrine we oppoſe do not likewiſe tend, in its own nature, (though not in the intentions of its patrons) to defeat God of much of that glory, which man both ought and might aſcribe to him, both for himſelf and the reſt of the creatures. How unlikely it is, that we ſhould be able to offer to God that glory, praiſe, and admiration, he both expects and merits from ſuch a contemplation of the creatures, as, though it be requiſite to the true knowledge of their nature and properties, is yet ſuppoſed either pernicious, or at leaſt dangerous; you, *Pyrophilus*, or any other impartial perſon may eaſily determine.

FOR the works of God are not like the tricks of jugglers, or the pageants, that entertain princes, where concealment is requiſite to wonder; but the knowledge of the works of God proportions our admiration of them, they participating and diſcloſing ſo much of the inexhauſted perfections of their author, that the further we contemplate them, the more foot-ſteps and impreſſions we diſcover of the perfections of their Creator; and our utmoſt ſcience can but give us a juſter veneration of his omniſcience. And as when ſome country fellow looks upon a curious watch, though he may be hugely taken with the rich enamel of the caſe, and perhaps with ſome pretty landſkip that adorns the dial-plate; yet will not his ignorance permit him ſo advantageous a notion of the exquiſite maker's ſkill, as that little engine will form in ſome curious artiſt, who beſides that obvious workmanſhip, that firſt entertains the eye, conſiders the exactneſs, and knows the uſe of every wheel, takes notice of their proportion, contrivance, and adaptation all together, and of the hidden ſprings, that move them all: ſo in the world, though every peruſer may read the exiſtence of a Deity, and be in his degree affected with what he ſees, yet he is utterly unable to deſcry there thoſe ſubtler characters and flouriſhes of omniſcience, which true philoſophers are ſharp-ſighted enough to diſcern. The exiſtence of God is indeed ſo legibly written on the creatures, that (as the Scripture ſpeaks in another ſenſe) *He may run, that reads it*; that is, even a perfunctory beholder, that makes it not his buſineſs, may perceive it: but that this God hath manifeſted in theſe creatures a power, a wiſdom, and a goodneſs worthy of himſelf, needs an attentive and diligent ſurveyor to diſcover. How different notions of God's wiſdom do the eggs of hens produce in the ordinary eaters of them, and

*Hab.* ii. 2.

and in curious naturaliſts, who carefully watch, and diligently obſerve, from time to time, the admirable progreſs of nature in the formation of a chick, from the firſt change appearing in the *cicatricula* (or little white ſpeck diſcernible in the coat of the egg's yolk) to the breaking of the egg-ſhell by the perfectly hatched bird; and on nature's exquiſite method in the order and faſhioning of the parts, make ſuch philoſophical reflections, as you may meet with (not to mention what *Ariſtotle* and *Fabricius ab Aquapendente* have obſerved on that ſubject) in the ingenious treatiſe of generation, which our accurate and juſtly famous anatomiſt, Dr. *Highmore*, has been pleaſed to dedicate to me; and in the excellent Exercitations *De Ovo* of that great promoter of anatomical knowledge, Dr. *Harvey*. And whereas it may be alledged, that the attributes of God, which are not taught us, but after much ſpeculation of the world, are things, of which no man but an atheiſt doubts; to this it may be replied, that beſides that it ill becomes the ſenſe we ought to have of our weakneſs to deſpiſe any helps vouchſafed us of God to aſſiſt us to know or ſerve him; beſides this, I ſay, God loving, as he deſerves, to be honoured in all our faculties, and conſequently to be glorified and acknowledged by the acts of reaſon, as well as by thoſe of faith, there muſt be ſure found a great diſparity betwixt that general, confuſed, and lazy idea we commonly have of his power and wiſdom, and the diſtinct, rational, affecting notions of thoſe attributes, which are formed by an attentive inſpection of thoſe creatures, in which they are moſt legible, and which are made chiefly for that very end. The queen of *Sheba* had heard in her own country a very advantageous fame of the wiſdom of *Solomon*; but when the curioſity of a perſonal viſit made her an eye-witneſs of thoſe particular both exquiſite ſtructures, and almoſt divinely prudent conducts and contrivances, wherein that wiſdom did inimitably diſplay itſelf, ſhe then brake forth into pathetick and venerating exclamations, that acknowledged how much juſter and improved a character (of his wiſdom) her eyes had now given her, than formerly her ears had done.

VERY like a philoſopher, methinks, does the great *Mercurius Triſmegiſtus* (if we grant him to be the author of the books aſcribed to him) ſpeak, when he tells his ſon, ‘There can be no religion more true or juſt, than to know the things that are, and to acknowledge thanks for all things to him, that made them; which things I ſhall not ceaſe to do.’ He continues; ‘Be pious and religious, O my ſon! for he, that does ſo, is the beſt and higheſt philoſopher; and without philoſophy, it is impoſſible ever to attain to the height and exactneſs of piety and religion.’ And it was perhaps, *Pyrophilus*, to engage us to an induſtrious indagation of the creatures, that God made man ſo indigent, and furniſhed him with ſuch a multiplicity of deſires; ſo that whereas other creatures are content with thoſe few obvious and eaſily attainable neceſſaries, that nature has almoſt every where provided for them; in man alone, every ſenſe has ſtore of greedy appetites, for the moſt part of ſuperfluities and dainties, that to relieve his numerous wants, or ſatisfy his more numerous deſires, he might be obliged with an inquiſitive induſtry to range, anatomize, and ranſack nature, and by that concerned ſurvey come to a more exquiſite admiration of the omniſcient author.

*Merc. Triſm.* l. 1. Engliſhed by Dr. *Everard*.

To illuſtrate this ſubject yet a little further, *Pyrophilus*, give me leave to obſerve to you, that philoſophers of almoſt all religions have been, by the contemplation of the world, moved to conſider it under the notion of a temple: *Ne adoremus* (ſays *Plutarch*) *elementa, cælum, ſolem, lunam, &c. ſpecula ſunt hæc, in quibus artem illius ſingularem intueamur, qui mundum condidit, & adornavit; nec eſt alius mundus quàm templum ejus:* ‘Let us not venerate the elements, the heaven, the ſun, the moon, &c. theſe are but mirrors, wherein we may behold his excellent art, who framed and adorned the world; nor is the world any thing but his temple.’ *Homines* (ſays *Cicero*) *tuentur*

That philoſophers of all religions have conſidered the world under the notion of God's temple.

*tur illum globum, quem in templo hoc medium vides, qui terra dicitur:* 'Men abide upon 'that globe, which you ſee in the middle of this temple, and is called the earth:' which *Macrobius* handſomely thus expounds; *Quicquid humano aſpectui ſubjicitur, templum ejus vocavit, qui ſola mente concipitur, ut qui hæc veneratur ut templa, cultum tamen maximum debeat Conditori, ſciatque quiſquis in uſum templi hujus inducitur, ritu ſibi vivendum ſacerdotis:* 'All that human view reaches, he terms his temple, who is apprehended by the mind alone; to the end, that whoſo reverences theſe things as temples, 'might render the greateſt worſhip to the Maker: and every one, that is brought to 'converſe in this temple, might know himſelf obliged to live like a prieſt.'

*Sen.* lib. 7. c. 7.

And the lofty *Seneca* (to mention now no other Heathens) in divers paſſages of his excellent writings, ſtyles the world a temple; and I remember, in his treatiſe *De Beneficiis*, he avers in terms not unworthy his mind or his ſubject, *Totum mundum deorum eſſe immortalium templum, ſolum quidem amplitudine illorum ac magnificentia dignum:* 'That the whole world is the temple of the immortal gods, being alone worthy of 'their grandeur and magnificence.' The aſſent of the Jewiſh philoſophers to this notion you may be pleaſed to receive from their eloquent *Philo*, who not only gives the world the name of temple, but gives us this account of that appellation; *Templum Dei ſupremum & verè tale exiſtimare totum hunc mundum, qui ſacrarium quidem habet, puriſſimam rerum naturæ partem, cœlum; ornamenta, ſtellas; ſacerdotes, adminiſtros potentiæ ejus, angelos, & incorporeas animas:* 'The whole world is to be accounted the chiefeſt 'temple of God; the *Sanctum Sanctorum* of it is of the pureſt part of the univerſe, 'heaven; the ornaments, the ſtars; the prieſts, the miniſters of his power, angels, 'and immaterial ſouls.' And as for Chriſtian philoſophers, I ſuppoſe it would be needleſs to enumerate the paſſages, wherein they adopt the notion of the world already mentioned; and therefore I ſhall content myſelf to add, that the ſcripture itſelf ſeems to authoriſe it by repreſenting to us, in the eighth or ninth chapters of the epiſtle to the Hebrews, the Moſaical tabernacle, as an adumbration of that great temple of the world; and particularly there is a ſignal text in the latter of thoſe chapters, where it is ſaid, that Chriſt is not entered into holy places made with hands [χειροποίητα ἅγια] which are copies of the true, [ἀντίτυπα τῶν ἀληθινῶν] but into heaven itſelf, now to appear in the preſence of God for us.

*Philo Jud.* de Monarchia.

*Heb.* viii. 2, 5.

*Heb.* ix. 24.

That in this temple man muſt be the prieſt.

Upon what account, *Pyrophilus*, I eſteem the world a temple, I may elſewhere have occaſion to declare; but this for the preſent: it will not be raſh to infer, that if the world be a temple, man ſure muſt be the prieſt, ordained (by being qualified) to celebrate divine ſervice not only in it, but for it. For as in ſchools, when the prince or ſome munificent benefactor confers ſome large poſſeſſion or rich annuity upon the foundation, though all the boys be concerned in the benefit, yet becauſe moſt of them are too young to be ſenſible of it, or too unlearned to be able to make the retribution of a handſome acknowledgement, either the maſter, or that other perſon of the ſociety, who is moſt capable and the beſt ſpokeſman, is by a kind of natural right engaged to the duty of returning praiſe and thanks, not for himſelf alone, but in the name of all the reſt; ſo in the world, where there are ſo many inanimate and irrational creatures, that neither underſtand, how much they owe to their Creator, by owing him even themſelves, nor are born to a condition enabling them to acknowledge it; man, as born the prieſt of nature, and as the moſt obliged and moſt capable member of it, is bound to return thanks and praiſes to his Maker, not only for himſelf, but for the whole creation. In which ſenſe we may reconcile thoſe two current aſſertions, *That God made all things for his own glory*, and *that God made all things for man, and man for himſelf.* Since whether or no man be a microcoſm or little world in *Paracelſus*'s ſenſe, if not as a reſembler, yet as a repreſenter of the macrocoſm or great world, he preſents with his own adorations the homages of all the creatures to their Creator, though they be ignorant of what is done, as infants under the law were of the ſacrifices offered on their account. And in this relation may the creatures anſwer the ſolemn invitation made them in the whole 148th Pſalm, and numerous other ſcriptures; which they may do (to borrow a barbarous, but ſignificant ſchool-term) objectively, though not formally; I mean, by proving occaſions, though not ſingers, of his praiſes; being ſuch objects, as prompt and invite man to pay God that praiſe upon their ſcore, which they cannot actually pay him themſelves; even God's muteſt works being capable of being ſaid to praiſe him in the ſame ſenſe (though in an incomparably tranſcendenter degree) that *Solomon* ſays of his virtuous woman (in the laſt verſe of the Proverbs) *Let her own works praiſe her in the gates*; that is, give the conſiderers of them occaſion to extol her: and thus by man's referring the knowledge of the creature to the Creator's glory, it becomes in ſome ſenſe, and congruouſly to its own nature, the praiſer of its maker, as may ſeem intimated in this oeconomy of the laſt part of one of the Pſalms, *Bleſs the Lord, all ye his hoſts, the miniſters of his, that do his pleaſure. Bleſs the Lord, all his works, in all places of his dominion: bleſs the Lord, O my ſoul.* Where, by ſhutting up the reſt of God's creatures betwixt angels and man's ſoul, he ſeems to inſinuate, that the irrational creatures bleſs the Lord by the mouth of thoſe, that are intelligent.

*Prov.* xxxi. 13.

*Pſal.* ciii.

The contemplation of God's mercy ought not ſo to ingroſs our thoughts, as to make us neglect the glory of his power and wiſdom.

AND truly, *Pyrophilus*, I fear it may reliſh a little of ſelfiſhneſs, to make ſuch a diſparity betwixt perfections, all of them equal, becauſe all of them infinite, as to let God's mercy, becauſe it moſt advantages us, ſo to ingroſs our thoughts and wonder, as to make us neglect the contemplation of thoſe other glorious attributes, his power and his wiſdom, which were thoſe, that exacted both man and angels adoration, before ſin gave occaſion to the exerciſe of the firſt. And I ſhall not ſcruple to confeſs unto you, that I dare not confine the acts of devotion to thoſe, which moſt men ſuppoſe to comprize the whole exerciſe of it: not that I at all undervalue, or would depreciate any, even the meaneſt practices of devotion, which either Scripture, or reaſon conſonant to it, recommends; but that I eſteem, that God may be alſo acceptably (and perhaps more nobly) ſerved and glorified by our entertaining of high, rational, and, as much as our nature is capable of, worthy notions, attended with a profound and proportionable admiration of thoſe divine attributes and prerogatives, for whoſe manifeſting he was pleaſed to conſtruct this vaſt fabrick.

To which purpoſe I conſider, that in the life to come, when we ſhall queſtionleſs glorify God exactlieſt, we ſhall have little either need or uſe of faith, prayer, liberality, patience, and reſembling graces; but our worſhip will chiefly conſiſt in elevated notions, and a proſtrate veneration of God's omnipotence, wiſdom, goodneſs, and other perfections; and ſuch a one as this is repreſented in the *Apocalypſe*, to be the preſent imployment of the bleſſed ſpirits in heaven, where the elders, that aſſiſt about the throne of God, are deſcribed caſting their crowns before it, and ſaying to him, that ſits on it, *Thou art worthy, O Lord, to receive glory, and honour, and power: for thou haſt created all things, and for thy pleaſure they are and were created.*

*Rev.* iv. 11.

BY this time, *Pyrophilus*, I hope you begin to think, that the doctrine, that tends to deter men from inquiring into nature, is as well derogatory from God's glory, as prejudicial to man's intereſts. And indeed, I purpoſed to content myſelf with the having diſperſed, throughout the paſt diſcourſe, the grounds of anſwering their objection againſt the ſtudy of phyſiology, who pretend it is apt to make men atheiſts: but becauſe I am much concerned to have you ſatisfied of ſo important a truth, as that, which we have hitherto been labouring to evince, I muſt beg your leave, *Pyrophilus*, to add *ex abundanti* (as they ſpeak) to what has been already alledged, ſome things, that may more directly anſwer the objection of our adverſaries, and manifeſt, how little their ſeverity is befriended, either by Scripture, reaſon, or experience.

AND firſt, it ſeems not at all probable, that if the omniſcient Author of nature knew, that the ſtudy of his works did really tend to make men diſbelieve his being or attributes, he would have given men ſo many invitations, and almoſt neceſſities, to ſtudy and contemplate the nature of his creatures. Of theſe invitations divers have been mentioned already, and more might be added to them, if we thought it requiſite. But what has been above alledged, will make us forbear the annexing of any, ſave that of the ancient inſtitution of the ſabbath, which many eminent divines do not groundleſly hold to have been ordained to commemorate the creation, and give men the opportunity every ſeventh day to contemplate God in his works, as he himſelf was pleaſed to reſt on the firſt ſeventh day, and contemplate himſelf in the works of the firſt ſix. And though our weſtern churches, for certain reaſons (not here to be inquired into) have long ſince diſuſed the ſolemnizing of the Saturday, and appointed the Sunday for the celebration of both the works of the redemption, and creation of the world together; yet it is evident enough, that the primitive Chriſtians did for the moſt part keep the Saturday as holy-day, as well as the Sunday: for that ancient book (whoever be reſolved to have written it) which goes under the name of *Clement*'s *Conſtitutions*, affords us, among others, theſe two memorable paſſages to our purpoſe: and firſt, Τὸ Σάϐϐατον μέντοι (ſays he) καὶ τὴν κυριακὴν ἑορτάζετε, ὅτι τὸ μὲν δημιȣργίας ἐςὶν ὑπόμνημα, ἡ δὲ ἀναςάσεως. *Keep the ſabbath and the Lord's day as holy days; that being dedicated to the remembrance of the creation, and this to that of the redemption.* To which we ſhall add this ſecond paſſage of the ſame author, Ἐργαζέσθωσαν οἱ δȣ̃λοι, &c. *Let ſervants work for five days; but on the ſabbath, and the Lord's day, let them attend in the church the doctrine of godlineſs.* To which purpoſe, I remember the moſt learned *Grotius* obſerves, that the converted emperor *Conſtantine* forbad the compelling Chriſtians to appear before tribunals on either of thoſe days, as being their feſtivals: Nay, and if modern travellers do not miſ-inform me, I find, that divers of the eaſtern churches, particularly the * Abyſſine Chriſtians, to this day, do as well ſanctify the ſabbath-day in commemoration of God's having created the world, as the Lord's-day to commemorate the reſurrection of Chriſt. And as for the Jews ſenſe of the fourth commandment, ſome of the learnedeſt of their criticks are pleaſed to diſtinguiſh betwixt the words *zachôr* and *ſhamôr*, *remember* and *keep*, imployed in the command of ſolemnizing the ſabbath: for, the remembering of it they hold to be an act of religion, performable by all mankind, that are capable of it, and acquainted with its having been commanded; though the keeping of it holy they ſuppoſe only enjoined to the Iſraelites. On which occaſion I remember I was one ſabbath-day entertained at his own lodgings, by a learned Jew (who taught me the holy language) with meat then newly dreſſed; to remove my wonder at which, he told me, 'That it was dreſſed by Chriſtians, who, 'being Gentiles, were not obliged to the ſtrict and legal obſervation of the ſabbath.' But whatever be thought of this Jewiſh notion, yet queſtionleſs, if the fourth commandment do not, at leaſt, divers other paſſages of ſcriptures do much diſcountenance their ſeverity, who would fright men from the indagation of nature. And he, that ſhall duly conſider divers texts obvious enough in the book of *Job*, and the *Pſalms* (beſides other parts of the Bible) will not readily conclude, that natural philoſophy and divinity are at ſuch variance, as the divines we deal with would perſuade us. St. *Paul* ſeems to inform us, that the inviſible things of God, from the creation of

Proved further from the ancient inſtitution of the Sabbath.

Lib. viii. c. 24.

Rom. i. 20.

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* See of the Abyſſine or Æthiopian Chriſtians, and likewiſe of the Maronites in the Eaſt, in reference to their celebration of the Saturday, *Alex. Roſſe*, in his *View of all Religions*, and the Authors by him cited.

the world, are clearly ſeen, being underſtood by the things, that are made, even *his eternal power and Godhead:* ſo that they, that were mentioned before, are without excuſe. And though I ignore not, that not only ſeveral of the Socinians following their maſter *Socinus*, but ſome few orthodox writers, are pleaſed to give a very differing interpretation of that text, and make the ἀόρατα ἀυτȣ ἀπο κτίσεως κόσμȣ, to ſignify thoſe things of God, that have been inviſible ever ſince the creation of the world, and referring the ποιήματα *to things not made*, as we tranſlate it, *but done* (as the miracles of Chriſt and his apoſtles) yet I ſee no neceſſity, why the ποιήματα ſhould be taken in a ſenſe excluſive of the creation, and not at leaſt admitted to take in all the ways and methods imployed by God, to manifeſt the *inviſible things* there intimated unto man. And certainly, however St. *Paul* may be ſuppoſed to appear but darkly, yet *Job* was clearly of a differing opinion from theirs, who teach, *That the ſtudy of nature leads to atheiſm: for aſk now the beaſts* (ſays he) *and they will teach thee; and the fowls of the air, and they ſhall tell thee; or ſpeak to the earth, and it ſhall teach thee; and the fiſhes of the ſea ſhall declare unto thee. Who knoweth not in all theſe, that the hand of the Lord hath wrought this?* And conſonantly hereunto (which it were not amiſs for our adverſaries to take notice of) we may obſerve; That almoſt all the writers of natural theology, and the moſt alſo of thoſe, that have laboured to demonſtrate the truth of Chriſtian religion (divers of whom have been as well profound divines, as otherwiſe eminent ſcholars) have undertaken to evince, by the conſideration of the univerſe, both that there is a God, and that he is the author of it. Which I the rather mention, *Pyrophilus*, becauſe I would not be miſtaken, as if I diſputed againſt divines in general, or were guilty of the leaſt irreverence towards a faculty, in whoſe ſtudy I have thought my ſelf obliged, as a Chriſtian, to ſpend much of my time; and eſpecially, I would not appear diſreſpectful to divines in *England*, where they have already been but too much vilified, though queſtionleſs for their ſins againſt God, yet, I fear, not without the ſin of their oppreſſors.

*Job* xii. 7, 8, 9.

IN the next place I conſider, that ſince phyſiology is ſaid to tempt to atheiſm, but by enabling men to give an account of the phænomena of nature, by the knowledge of ſecond cauſes, without taking in the firſt, it will not be ſo eaſy a matter, as many preſume, for the contemplation of nature, to turn a conſidering man atheiſt. For we are yet, for aught I can find, far enough from being able to explicate all the phænomena of nature by any principles whatſoever. And even of the atomical philoſophers, whoſe ſect ſeems to have the moſt ingeniouſly attempted it, ſome of the eminenteſt have themſelves freely acknowledged to me, their being unable to do it convincingly to others, or ſo much as ſatisfactorily to themſelves. And indeed, not only the generation of animals is a myſtery, which all, that naturaliſts have ſaid to explain it, have been far enough from depriving of that name; but we ſee, that to explicate all the various phænomena, that belong to that ſingle inanimate, and ſeemingly homogeneous body, mercury, ſo as not to make any hypotheſis aſſumed, to make out one of its properties or effects, incongruous to any other hypotheſis requiſite to the explanation of any of the reſt, hath been hitherto found ſo difficult, that if our poſterity be not much happier unriddlers, than our forefathers or we have been, it is like to prove a taſk capable of defeating the induſtry and attempts, I ſay not of more than one philoſopher, but of more than one age; even our chymical tortures hitherto having, from that deluding *Proteus*, forced no confeſſions, that bring us not more wonder than ſatisfaction, and do not beget almoſt as many ſcruples, as they reſolve.

That Phyſiologers cannot explicate by ſecond cauſes all the phænomena of nature, ſo as to exclude the firſt.

# ESSAY IV.

## *Containing a requiſite Digreſſion concerning thoſe, that would exclude the Deity from intermeddling with Matter.*

That ſome of the Peripatetick ſect are guilty of this endeavour.

IGNORE not, that not only *Leucippus*, *Epicurus*, and other Atomiſts of old, but of late ſome perſons, for the moſt part adorers of *Ariſtotle*'s writings, have pretended to be able to explicate the firſt *beginning of things* and the world's phænomena, without taking in, or acknowledging any divine Author of it. And therefore, though we may elſewhere, by the aſſiſtance of that author, have an opportunity to give you an account of our unſatisfiedneſs with the attempts made by ſome bold wits in favour of ſuch pretenſions; yet ſince the main truth we plead for in this diſcourſe, is ſo nearly concerned in what hath been taught by thoſe, that would keep God from being thought to have any ſhare in the production of the univerſe, I can ſcarce forbear (as unwilling as I am to digreſs) to repreſent to you, on the preſent occaſion, a few conſiderations, which may aſſiſt you, if not to leſſen the arrogance of ſuch perſons, at leaſt, to keep your ſelf from thinking their evidence as great, as their confidence is wont to be. Now of the philoſophers we ſpeak of, ſome being Atomiſts, and others not, it will be requiſite to ſay ſomething to each of the two ſorts: and becauſe we not long ſince, in an illuſtrious company, where you, *Pyrophilus*, are not unknown, met with one of them, who avowedly grounded his opinions on the Ariſtotelian or vulgar phyſiology, we ſhall firſt recommend to you two or three conſiderations concerning ſuch arrogant Peripateticks, (for I ſpeak not of that ſect in general, of which I know there are divers excellent men.)

That their hypotheſis is very full of miſtakes.

FIRST then, you will in many paſſages of the following eſſays, find, that divers things, that have been very magiſterially taught, and confidently believed among the followers of *Ariſtotle*, are errors or miſtakes; and that as ſeveral, even of the obvious phænomena of nature, do contradict the common Peripatetick doctrine, ſo divers, at leaſt of thoſe, that are more abſtruſe, are not explicable by it: and as confidently as theſe his followers talk of the expounding the very riddles of nature; yet I remember, that he himſelf ſomewhere (for I cannot call to mind the place) did not ſcruple to confeſs, that *As the eyes of owls are to the ſplendor of the day, ſo are thoſe of our minds even to things obvious and manifeſt.*

That theſe excluders of the Deity make but imperfect explications of the phænomena of nature.

I SHALL next take notice, that philoſophers, who ſcorn to aſcribe any thing to God, do often deceive themſelves, in thinking they have ſufficiently ſatisfied our inquiries, when they have given us the neareſt and moſt immediate cauſes of ſome things; whereas oftentimes the aſſignment of thoſe cauſes is but the manifeſting, that ſuch and ſuch effects may be deduced from the more catholick affections of things, though theſe be not unfrequently as abſtruſe, as the phænomena explicated by them, as having only their effects more obvious, not their nature better underſtood: as when, for inſtance, an account is demanded of that ſtrange ſuppoſed ſympathy betwixt quickſilver and gold; in that we find, that whereas all other bodies ſwim upon quickſilver, it will readily ſwallow up gold, and hide it in its boſom. This pretended ſympathy the naturaliſt may explicate, by ſaying, that gold being the only body heavier than quickſilver of the ſame bulk, the known laws of the Hydroſtaticks make it neceſſary, that gold ſhould ſink in it, and all lighter bodies ſwim on it. But though the cauſe of this effect be thus plauſibly aſſigned, by deducing it from ſo known and obvious an affection of bodies, as gravity, which every man is apt to think he ſufficiently underſtands; yet will not this put a ſatisfactory period to a ſevere inquirer's curioſity, who will, perchance, be apt to alledge, that though the effects of gravity indeed be very obvious, yet the cauſe and nature of it are as obſcure, as thoſe of almoſt any phænomenon it can be brought to explicate. And that therefore he, that deſires no further account, deſiſts too ſoon from his inquiries, and acquieſces long before he comes to his journey's end *. And indeed, the inveſtigation of the true nature and adequate cauſe of gravity, is a taſk of that difficulty, that in ſpite of aught I have hitherto ſeen or read, I muſt yet retain great doubts, whether they have been clearly and ſolidly made out by any man. And ſure, *Pyrophilus*, there are divers effects in nature, of which though the immediate cauſe may be plauſibly aſſigned, yet if we further inquire into the cauſes of thoſe cauſes, and deſiſt not from aſcending in the ſcale of cauſes, till we are arrived at the top of it, we ſhall perhaps find the more catholick and primary cauſes of things to be either certain, primitive, general, and fixt laws of nature (or rules of action and paſſion among the parcels of the univerſal matter,) or elſe the ſhape, ſize, motion, and other primary affections of the ſmalleſt parts of matter, and of their firſt coalitions or cluſters †; eſpecially thoſe endowed with ſeminal faculties or properties, or (to diſpatch) the admirable conſpiring of the ſeveral parts of the univerſe to the production of particular effects; of all which it will be difficult to give a ſatisfactory account, without acknowledging an intelligent author or diſpoſer of things.

And do not explain the ſcale of cauſes unto the laſt cauſe.

AND the better to clear ſo weighty a truth, let us further conſider on this occaſion, that not only *Ariſtotle*, and thoſe that, miſ-led by his authority, maintain the eternity of the world, but very many other philoſophers and phyſicians, who aſcribe ſo much to nature, that they will not be reduced to acknowledge an author of it, are wont very much to delude both themſelves and others in the account they preſume to give us, as ſatisfactory, of the cauſes or reaſons of very many effects. I will not inſtance in the magnetick properties of things, nor any of thoſe numerous abſtruſities of nature, which it is well-known that the Ariſtotelians are wont to refer to ſympathy, antipathy, or occult qualities, and ſtrive to put men off with empty names, whereby they do not ſo much leſſen our ignorance, as betray their own.

Inſtances of things, wherein their account is not ſatisfactory; as 1. In the particulars, the cauſes of which, they aſſign occult qualities.

BUT I ſhall inſtance in thoſe more obvious phænomena, of which they ſuppoſe they have given us very ſatisfactory accounts. If you aſk one of thoſe I ſpeak of, whence it comes to paſs, that if a man put one end of a long reed into a veſſel full of water, and ſuck at the other end, his mouth will be immediately filled with that liquor; he will readily tell you, that the ſuction drawing the air out of the cavity of the reed, the water muſt neceſſarily ſucceed in the place deſerted by the air, to prevent a vacuity abhorred by nature. If you likewiſe aſk ſuch a man, why too in women, about a certain age, the *purgationes menſtruæ* do commonly ſupervene; he will think he has ſufficiently anſwered you, when he has told you, that about that age, beginning to be ripe for procreation, nature has wiſely provided, that their ſuperfluous blood ſhould be ſent to the uterine veſſels, partly to diſburden the maſs of blood of an uſeleſs load, and partly to contribute matter, or at leaſt afford nouriſhment in caſe of conception. But though theſe ſolutions are wont to be acquieſced in by ſuch as thoſe that give them, yet I ſee not how they can ſatisfy a rigid reaſoner. For not now to mention, what may be objected againſt them out of ſome modern mechanical and anatomical obſervations, let us a little conſider, that to ſay, that the aſcent of the water in the firſt problem pro-

2. When they aſſign nature's abhorrency of vacuity to be the cauſe, that water doth aſcend in ſuction.

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* Phyſiologo qui veritatem contemplatur ultimarum cauſarum cognitio non finis eſt, ſed initium ad primas ſupremaſque cauſas proficiſcendi. *Plutarch*. l. de primo Frigido.

† Τὸ πρῶτον αἴτιον ἐν τῇ εὑρήσει ἔσχατον. *Ariſtot*. Eth c. Nicom. Lib. III. cap. 8.

ceeds from nature's deteſtation of a vacuity, ſuppoſes that there is a kind of *anima mundi*, furniſhed with various paſſions, which watchfully provides for the ſafety of the univerſe; or that a brute and inanimate creature, as water, not only has a power to move its heavy body upwards, contrary (to ſpeak in their language) to the tendency of its particular nature, but knows both that air has been ſucked out of the reed, and that unleſs it ſucceed the attracted air, there will follow a vacuum; and that this water is withal ſo generous, as by aſcending, to act contrary to its particular inclination for the general good of the univerſe, like a noble patriot, that ſacrifices his private intereſts to the publick ones of his country.

Whereas the contrary is proved in the ſuction of the quickſilver.

BUT to ſhew men by an eaſy experiment, how little attraction is performed to avoid a vacuum, I have ſometimes done thus. I have taken a ſlender pipe of glaſs, of about four foot long, and putting one of the open ends of it into a veſſel full of quickſilver, I have ſucked as ſtrongly as I could at the other, and cauſed one to watch the aſcent of the quickſilver, and mark where it was at the higheſt, and I found not, that at one ſuck I could raiſe it up much above a foot; and having cauſed a couple of ſtrong men, one after another, to ſuck at the ſame end of the ſame pipe, I found not, that either of them could draw it up much higher. Nor did it appear, that by repeated ſuctions, though the upper end of the pipe were each time ſtopt, to hinder the relapſe of the quickſilver, it could at all be raiſed above the ſeven and twenty digits, at which it uſed to ſubſiſt in the Torricellian experiment *de vacuo*. Whereas the ſame end of the tube being put into a ſmall veſſel of water, I could at one ſuck make the water ſwiftly aſcend through the perpendicularly held tube into my mouth; which argues, that the aſcenſion of liquors upon ſuction rather depends upon the preſſure of the air (againſt the liquors and the ſucker's cheſt) and their reſpective meaſures of gravity and lightneſs compared to that preſſure, than it proceeds from ſuch an abhorrency of a vacuum as is preſumed.

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How far ſuch borrowed and metaphorical phraſes, which cuſtom has authoriſed, may be uſed.

Quickſilver being heavier than ſtones, they ſwim thereon, yet ſink in lighter liquors.

circular motion, becauſe it conſtantly moves round the center of the dial-plate, it is evident, that the inanimate piece of metal affects not that motion more than any other, but only, that the impreſſion it receives from the wheels, and the adaptation of the reſt of the engine, determine it to move after that manner. And though if a man ſhould with his finger ſtop that index from proceeding in its courſe, it may be ſaid, in ſome ſenſe, that it ſtrives or endeavours to proſecute its former circular motion; yet that will ſignify no more, than that by virtue of that contrivance of the engine, the index is ſo impelled, that if the obſtacle, put by the finger of him that ſtops it, were taken away, the index would move onwards, from that part of the circle where it was ſtopt, towards the mark of the next hour. Nor do I, by this, *Pyrophilus*, deny, that it may in a right ſenſe be ſaid, as it is wont to be in the ſchools, that *Opus naturæ eſt opus intelligentiæ:* neither do I reject ſuch common expreſſions as *nature always affects and intends that which is beſt*, and *nature doth nothing in vain*. For ſince I muſt, according to the above mentioned notion, refer many of the actions of irrational creatures to a moſt wiſe Diſpoſer of things, it can ſcarce ſeem ſtrange to me, that in thoſe particulars, in which the author intended, as it was requiſite, that irrational creatures ſhould operate ſo and ſo for their own preſervation, or the propagation of their ſpecies, or the publick good of the univerſe, their actions being ordered by a reaſon tranſcending ours, ſhould not only oftentimes reſemble the actings of reaſon in us, but ſometimes even ſurpaſs them. As in effect we ſee ſilk-worms and ſpiders can, without being taught, ſpin much more curiouſly their balls and webs, than our beſt ſpinſters could; and that ſeveral birds can build and faſten their neſts more artificially, than many a man, or perhaps any man could frame and faſten ſuch little and elaborate buildings. And the induſtries of foxes, bees, and divers other beaſts, are ſuch, that it is not much to be wondered at, that thoſe creatures ſhould have reaſon aſcribed to them by divers learned men; who yet perhaps would be leſs confident, if they conſidered how much may be ſaid for the immortality of all rational ſouls, and that the ſubtile actings of theſe beaſts are determined to ſome few particulars requiſite for their own preſervation, or that of their ſpecies; whereas, on all other occaſions, they ſeem to betray their want of reaſon, and by their voice and geſtures ſeem to expreſs nothing, but the natural paſſions, and not any rational or logical conceptions. And therefore, as when (to reſume our former compariſon) I ſee in a curious clock, how orderly every wheel and other parts perform its own motions, and with what ſeeming unanimity they conſpire to ſhew the hour, and accompliſh the other deſigns of the artificer; I do not imagine, that any of the wheels, &c. or the engine it ſelf is endowed with reaſon, but commend that of the workman, who framed it ſo artificially. So when I contemplate the actions of thoſe ſeveral creatures, that make up the world, I do not conclude the inanimate pieces, at leaſt, that it is made up of, or the vaſt engine it ſelf, to act with reaſon or deſign, but admire and praiſe the moſt wiſe Author, who by his admirable contrivance can ſo regularly produce effects, to which ſo great a number of ſucceſſive and conſpiring cauſes are required.

That the inſtances of the action of divers creatures, reſembling reaſon, commend the wiſdom of God.

And thus much, *Pyrophilus*, having been repreſented concerning thoſe, that rejecting from the production and preſervation of things all but nature, yet embrace the principles of the vulgar philoſophy, you will perhaps think it more than enough; but object, that what is not to be expected from the barren principles of the ſchools, may yet be performed by thoſe atomical ones, which we ourſelves have, within not very many pages, ſeemed to acknowledge ingenious. And I know indeed, that the modern admirers of *Epicurus* confidently enough pretend, that he and his expoſitors have already, without being beholden to a Deity, clearly made out, at leaſt the origin of the world, and of the principal bodies it is made up of. But I confeſs, I am ſo far from being convinced of this, that I have been confirmed rather, than unſettled in my opinion of the difficulty of making out the original of the world, and of the creatures, eſpecially the living ones, that compoſe it, by conſidering the accounts which are given us of the nativity (if I may ſo ſpeak) of the univerſe, and of animals, by thoſe great denyers of creation and providence, *Epicurus*, and his paraphraſt *Lucretius:* whoſe having ſhown themſelves (as I freely confeſs they have) very ſubtile philoſophers in explicating divers myſteries of nature, ought not ſo much to recommend to us their impious errors about the original of things, as to let us ſee the neceſſity of aſcribing it to an intelligent cauſe. This then is the account of this matter, which is given us by *Epicurus* himſelf, in that epiſtle of his to *Herodotus*, which we find in *Diogenes Laertius: Quod ad meteora attinet, exiſtimari non oportet, aut motum, aut converſionem, aut eclipſin, aut ortum occaſumvè, aut alia hujuſcemodi ideo fieri, quod ſit præfectus aliquis, qui ſic diſponat, diſpoſueritvè, ac ſimul beatitudinem immortalitatemque poſſideat:* ‘ As to the meteors, you ought not to believe, that there is either motion, ‘ or change, or eclipſe, or the riſe or ſetting of them, becauſe of any ſuperior preſident, ‘ which doth, or hath ſo diſpoſed of it, and himſelf poſſeſſes all the while happineſs ‘ and immortal life.’ And having interpoſed ſome lines, to prove, that the providence of God is not conſiſtent with his felicity, he adds, *Quare opinandum eſt, tum cum mundus procreatus eſt, factos fuiſſe eos circumplexus convolventium ſe atomorum, ut nata fuerit hæc neceſſitas, quâ circuitus tales obierint:* ‘ Wherefore you muſt think, that when the world ‘ was made, thoſe implications and foldings of atoms happened, which cauſed this neceſſity, that theſe bodies ſhould paſs through theſe motions.’ And elſewhere in the ſame epiſtle: *Infiniti* (ſays he) *ſunt mundi, alii ſimiles iſti, alii vero diſſimiles. Quippe atomi cum ſint infinitæ, ut non multo ante demonſtratum eſt per infinitatem ſpatiorum, & alibi aliæ, ac procul ab hoc ad fabrefactionem mundorum infinitorum variè concurrunt.* ‘ There are infinite worlds, ſome like this, ſome unlike it: for ſince atoms are infinite ‘ (as I newly ſhewed from the infiniteneſs of the ſpaces) ſome in one, other in others, ‘ diſtant parts of theſe ſpaces far from us, variouſly concur to the making of infinite ‘ worlds.’ And leſt this Epicurean explication of the world’s original ſhould ſeem to owe all its unſatisfactorineſs to its obſcure brevity, we ſhall not ſcruple to give you that elegant paraphraſe and expoſition of it, which *Lucretius* has delivered in his 5th book, *De Rerum Natura:*

Defects in the explication of nature by the Epicureans, who deny the concurrence of God.

*Sed quibus ille modis, conjectus materiaï*
*Fundarit cœlum, ac terram pontique profunda*
*Solis, lunaï curſus ex ordine ponam,*
*Nam certe neque conſiliis primordia rerum*
*Ordine ſe quæque atque ſagaci mente locarunt,*
*Nec quos quæque darent motus pepigere profectò:*
*Sed quia multa modis multis primordia rerum*
*Ex infinito jam tempore percita plagis,*
*Ponderibuſque ſuis, conſuerunt concita ferri,*
*Omnimodiſque coïre, atque omnia pertentare,*
*Quæcunque inter ſe poſſent congreſſa creare;*
*Propterea fit, ut magnum volgata per ævum,*
*Omnigenos cœtus & motus experiundo,*
*Tandem conveniant: ea quæ conjuncta repentè*
*Magnarum rerum fiant exordia ſæpè*
*Terraï maris, & cœli generiſque animantum.*

‘ But how at firſt, when matter thus was whirl'd,
‘ Heaven, earth, and ſea, the high and lower world,
‘ The ſun and moon, and all were made, I'll ſhew,
‘ For ſure the firſt rude atoms never knew
‘ By ſage intelligence, and counſel grave,
‘ T' appoint the places, that all beings have:
‘ Nor will I think, that all the motions here
‘ Order'd at firſt by fixt agreements were,
‘ But th' elements, that long had beat about,
‘ Been buffetted, now in, now carried out:
‘ Screwed into every hole, and tried to take
‘ With any thing, in any place to make
‘ Somewhat at laſt; after much time and coil,
‘ Motions and meetings, and a world of toil
‘ Made up this junto. And thus being join'd,
‘ And thus in kind embraces firmly twin'd,
‘ And link'd together, they alone did frame,
‘ Heaven, earth, and ſea, and the creatures in the ſame.’

THE hypotheſis expreſſed in theſe verſes (which pleaſe our author ſo well, that he has almoſt the ſame lines in ſeveral other places of his poem) he proſecutes and applies to ſome particular parts of the univerſe in the ſame 5th book: but whilſt he thus refuſeth to allow God an intereſt in the world's production, his hypotheſis requires, that we ſhould allow him ſeveral things, which he doth aſſume, not prove: as firſt, that matter is eternal. 2. That from eternity it was actually divided, and that into ſuch inſenſibly ſmall parts, as may deſerve the name of atoms; whereas it may be ſuppoſed, that matter, though eternal, was at firſt one coherent maſs, it belonging to matter to be diviſible, but not ſo of neceſſity, to be actually divided. 3. That the number of theſe atoms is really infinite. 4. That theſe atoms have an *inane infinitum* (as the Epicureans ſpeak) to move in. 5. That theſe atoms are endowed with an almoſt infinite variety of determinate figures, ſome being round, others cubical, others hooked, others conical, *&c.* whereas not to mention beforehand what we may elſewhere object beſides againſt this aſſumption, he ſhews not why, nor how this atom came to be ſpherical rather than conical, and another hooked rather than pyramidal: but theſe aſſumptions I inſiſt not on, becauſe of two others much more conſiderable, which our author is fain to take for granted in his hypotheſis. For 6thly, he ſuppoſes his eternal atoms to have from eternity been their own movers, whereas it is plain, that motion is no way neceſſary to the eſſence of matter, which ſeems to conſiſt principally in extenſion: for matter is no leſs matter when it reſts, than when it is in motion; and we daily ſee many parcels of matter paſs from the ſtate of motion to that of reſt, and from this to that, communicating their motion to matter that lay ſtill before, and thereby loſing it themſelves. Nor has any man, that I know, ſatisfactorily made out how matter can move itſelf: and indeed, in the bodies, which we here below converſe withal, we ſcarce find, that any thing is moved but by ſomething elſe; and even in theſe motions of animals, that ſeem ſpontaneous, the will or appetite doth not produce the motion of the animal, but guide and determine that of the ſpirits, which by the nerves move the muſcles; and ſo the whole body, as may appear by the wearineſs and unwieldineſs of animals, when by much motion the ſpirits are ſpent. And accordingly I find that *Anaxagoras*, though he believed, as *Ariſtotle* did after him, that matter was eternal, yet he diſcerned, that the notion of matter not neceſſarily including motion, there was a neceſſity of taking in a *mens*, as he ſtyles God, to ſet this ſluggiſh matter a moving. And I remember *Ariſtotle* himſelf, in one place of his Metaphyſicks, diſputing againſt ſome of the ancienter philoſophers, aſks, *Quonamque modo movebuntur, ſi nulla erit actu cauſa? non enim ipſa materia ſeipſam movebit,* ἀλλὰ τεκτονικὴ *rerum opifex virtus*: ' How ' ſhall things be moved, if there be no actual cauſe? For matter cannot move itſelf, ' but requires to be moved by a tectonick thing, creating power.' But though elſewhere I have met with paſſages of his near of kin to this, yet he ſeems not to expreſs his opinion uniformly and clearly enough to engage me to define it, or make a weapon of it: and therefore I ſhall rather proceed to take notice, that, according to the Epicurean hypotheſis, not only the motion, but the determination of that motion is ſuppoſed. For *Epicurus* will have his atoms move downwards, and that not in parallel lines, leſt they ſhould never meet to conſtitute the world, but according to lines ſomewhat inclining towards one another; ſo that there muſt be not only motion, but gravity in atoms, before there be any center of gravity for them to move towards; and they muſt move rather downwards than upwards, or ſideways, and in ſuch lines as nothing is produced capable of confining them to. Which are aſſumptions ſo bold and precarious, that I find ſome, even of his admirers, to be aſhamed of them: which will ſave me the labour of arguing againſt them, and allow me to take notice in the ſeventh place, that this Epicurean doctrine ſuppoſes, that a ſufficient number of atoms, and their motion downwards, being granted, there will need nothing but their fortuitous concourſe in their fall, to give a being to all thoſe bodies, that make up the world. Indeed, that the various coalitions of atoms, or at leaſt ſmall particles of matter, might have conſtituted the world, had not been perhaps a very abſurd opinion for a philoſopher, if he had, as reaſon requires, ſuppoſed, that the great maſs of lazy matter was created by God at the beginning, and by him put into a ſwift and various motion, whereby it was actually divided into ſmall parts of ſeveral ſizes and figures, whoſe motion and croſſings of each other were ſo guided by God, as to conſtitute, by their occurſions and coalitions, the great inanimate parts of the univerſe, and the ſeminal principles of animated concretions. And therefore I wonder not much, that the Mileſian *Thales* (the firſt of the Grecian philoſophers, as *Cicero* informs us, that inquired into theſe matters) ſhould hold that opinion, which *Tully* expreſſes in theſe words: *Aquam dixit eſſe initium rerum, Deum autem eam mentem, quæ ex aqua cuncta finxerat*: ' He ſaid, ' water was the principle of all things, but God was that intelligence, that made all ' things out of water:' And that of *Anaxagoras* the ſame author ſhould give us this account; *Omnium rerum deſcriptionem & modum mentis infinitæ vi ac ratione deſignari & confici voluit*: ' The delineation and manner of all things he thought to be deſigned ' and made by the power and reaſon of infinite intelligence.' For though theſe great men exceedingly erred, in thinking it neceſſary, that God ſhould be provided of a pre-exiſtent, and by him not created matter, to make the world of; yet at leaſt they diſcerned and acknowledged the neceſſity of a wiſe and powerful agent, to diſpoſe and faſhion this rude matter, and contrive it into ſo goodly a ſtructure, as we behold, without imagining with *Epicurus*, that chance ſhould turn a chaos into a world. And really it is much more unlikely, that ſo many admirable creatures, that conſtitute this one exquiſite and ſtupendous fabrick of the world, ſhould be made by the caſual confluence of falling atoms, juſtling or knocking one another in the immenſe vacuity, than that in a printer's working-houſe a multitude of ſmall letters, being thrown upon the ground, ſhould fall diſpoſed into ſuch an order, as clearly to exhibit the hiſtory of the creation of the world, deſcribed in the third or fourth firſt chapters of *Geneſis*; of which hiſtory, it may be doubted, whether chance may ever be able to diſpoſe the fallen letters into the words of one line. I ignore not, that ſometimes odd figures,

*Ariſtot.* Metaphyſ. lib. 12. c. 6.

De Nat. Deorum. lib. 1.

Idem ibidem.

and almoſt pictures, may be met with, and may ſeem caſually produced in ſtones, and divers other inanimate bodies; and I am ſo far from denying this, that I may elſewhere have opportunity to ſhew you, that I have been no careleſs obſerver of ſuch varieties.

That the figures in nitre, cryſtal, and divers minerals are produced, not by chance, but by ſomewhat analogous to ſeminal principles.

BUT firſt, even in divers minerals, as we may ſee in nitre, cryſtal, and ſeveral others, the figures, that are admired, are not unqueſtionably produced by chance, but perhaps by ſomething analogous to ſeminal principles, as may appear by their uniform regularity in the ſame ſort of concretion, and by the practice of ſome of the ſkilfulleſt of the ſalt-petre men, who, when they have drawn as much nitre as they can out of the nitrous earth, caſt not the earth away, but preſerve it in heaps for ſix or ſeven years; at the end of which time, they find it impregnated with new ſalt-petre, produced chiefly by the ſeminal principle of nitre implanted in that earth. To prove, that metalline bodies were not all made at the beginning of the world, but have ſome of them a power, though ſlowly, to propagate their nature, when they meet with a diſpoſed matter; you may find many notable teſtimonies and relations in a little book of *Phyſico-chymical Queſtions*, written by *Jo. Conradus Gerhardus*, a German doctor, and moſt of them recited (together with ſome of his own) by the learned *Sennertus*. But leſt you ſhould ſuſpect the narratives of theſe authors, as ſomewhat partial to their fellow-chymiſts opinions, I ſhall here annex that memorable relation, which I find recorded by *Linſchotten*, and *Garcias ab Horto*, a pair of unſuſpected writers in this caſe, concerning diamonds; whereby it may appear, that the ſeminal principles of thoſe precious ſtones, as of plants, are lodged in the bowels of the mine they grow in. *Diamonds* (ſays the firſt, in that chapter of his travels, where he treats of thoſe jewels) *are digged like gold out of mines; where they digged one year the length of a man into the ground, within three or four years after, there are found diamonds again in the ſame place, which grow there; ſometimes they find diamonds of* 400 *or* 800 *grains. Adamantes* (ſays the latter) *qui altiſſimè in terræ viſceribus, multiſque annis perfici debebant in ſummo ferè ſolo generantur, & duorum aut trium annorum ſpatio perficiuntur: nam ſi in ipſa fodina hoc anno ad cubiti altitudinem fodias, adamantes reperies. Poſt biennium rurſus illic excavato ibidem, invenies adamantes.* 'Diamonds, which ought to be brought to perfection in the deepeſt bowels of the earth, 'and in a long tract of time, are almoſt at the top of the ground, and in three or four 'years ſpace made perfect. For if you dig this year but the depth of a cubit, you will 'find diamonds; and after two years dig there, you will find diamonds again.' And next, how inconſiderable, alas! are theſe ſuppoſed productions of chance, in compariſon of the elaborate contrivances of nature in animals? ſince in the body of man, for inſtance, of ſo many hundred parts it is made up of, there is ſcarce any, that can be either left out, or made otherwiſe than as it is, or placed elſewhere than where it is, without an apparent detriment to that curious engine; ſome of whoſe parts, as the eye, and the valves of the veins, would be ſo unfit for any thing elſe, and are ſo fitted for the uſes, that are made of them, that it is ſo far from being likely, that ſuch ſkilful contrivances ſhould be made by any being not intelligent, that they require a more than ordinary intelligence to comprehend how ſkilfully they are made.

Sempl. in India naſcenti, lib. 1. cap. 47.

That the generation of animals is much leſs to be accounted the production of chance.

As for the account that *Lucretius*, out of *Epicurus*, gives us of the firſt production of men, in I know not what wombs adhering to the ground, and which much more becomes him as a poet, than as a philoſopher; I ſhall not here waſte time to manifeſt its unlikelineſs, that witty father *Lactantius* *, having done already that copiouſly for me. And indeed it ſeems ſo pure a fiction, that, were it not, that the hypotheſis he took upon him to maintain, could ſcarce afford him any leſs extravagant account of the original of animals, the unſuitableneſs of this romance to thoſe excellent notions, with which he has enriched divers other parts of his works, would make me apt to ſuſpect, that when he writ this part of his poem, he was in one of the fits of that frenzy, which ſome, even of his admirers, ſuppoſe him to have been put into by a philtre, given him by his, either wife or miſtreſs, *Lucilia*; in the intervals of which, they ſay, that he writ his books.

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* Tanta ergo qui videat, & talia poteſt exiſtimare nullo affecta eſſe conſilio, nulla providentia, nulla ratione divina, ſed ex atomis ſubtilibus exiguis concreta eſſe tanta miracula? Nonne prodigio ſimile eſt, aut natum eſſe hominem, qui hæc diceret, ut Leucippum aut extitiſſe qui crederet, ut Democritum, qui auditor ejus fuit, vel Epicurum in quem vanitas omnis de Leucippi fonte profluxit. Lib. II. cap. 11.

That the hypotheſes of philoſophy only ſhew, that an effect may be produced by ſuch a cauſe, not that it muſt.

AND here let us further conſider, that as confidently as many atomiſts, and other naturaliſts, preſume to know the true and genuine cauſes of the things they attempt to explicate; yet very often the utmoſt they can attain to, in their explications, is, that the explicated phænomena may be produced after ſuch a manner, as they deliver, but not that they really are ſo. For as an artificer can ſet all the wheels of a clock a going, as well with ſprings as with weights; and may with violence diſcharge a bullet out of the barrel of a gun, not only by means of gunpowder, but of compreſſed air, and even of a ſpring: ſo the ſame effects may be produced by divers cauſes different from one another; and it will oftentimes be very difficult, if not impoſſible, for our dim reaſons to diſcern ſurely, which of theſe ſeveral ways, whereby it is poſſible for nature to produce the ſame phænomena, ſhe has really made uſe of to exhibit them. And ſure, he, that in a ſkilful watch-maker's ſhop ſhall obſerve, how many ſeveral ways watches and clocks may be contrived, and yet all of them ſhew the ſame things; and ſhall conſider how apt an ordinary man, that had never ſeen the inſide but of one ſort of watches, would be to think, that all theſe are contrived after the ſame manner, as that, whoſe fabrick he has already taken notice of; ſuch a perſon, I ſay, will ſcarce be backward to think, that ſo admirable an engineer as nature, by many pieces of her workmanſhip, appears to be, can, by very various and differing contrivances, perform the ſame things; and that it is a very eaſy miſtake for men to conclude, that becauſe an effect may be produced by ſuch determinate cauſes, it muſt be ſo, or actually is ſo. And as confident as thoſe we ſpeak of uſe to be, of knowing the true and adequate cauſes of things, yet *Epicurus* himſelf, as appears by ancient teſtimony, and by his own writings, was more modeſt, not only contenting himſelf, on many occaſions, to propoſe ſeveral poſſible ways, whereby a phænomenon may be accounted for, but ſometimes ſeeming to diſlike the ſo pitching upon any one explication, as to exclude and reject all others: and ſome modern philoſophers, that much favour his doctrine, do likewiſe imitate his example, in pretending to aſſign not preciſely the true, but poſſible cauſes of the phænomenon they endeavour to explain. And I remember, that *Ariſtotle* himſelf (whatever confidence he ſometimes ſeems to expreſs) does in his firſt book of *Meteors* ingenuouſly confeſs, that concerning many of nature's phænomena, he thinks it ſufficient, that they may be ſo performed as he explicates them. But granting, that we did never ſo certainly know, in the general, that theſe phænomena of nature muſt proceed from the magnitudes, figures, motions, and thence reſulting qualities of atoms, yet we may be very much to ſeek as to the particular cauſes of this or that particular effect or event. For it is one thing to be able to ſhew it poſſible, for ſuch and ſuch effects to proceed from the various magnitudes, ſhapes, motions, and concretions of atoms; and another thing to be able to declare what preciſe, and determinate figures, ſizes, and motions of atoms, will ſuffice to make out the propoſed phænomena, without incongruity to any others to be met with in nature: as it is one thing for a man ignorant of the mechanicks to make it plauſible, that the motions of the famed clock at *Straſburg*, are performed by the means of certain wheels, ſprings, and weights, *&c.* and another to be able to deſcribe diſtinctly the magnitude, figures, proportions, motions, and,

That to a perfect knowledge there muſt not only appear the poſſible, but the definite and real; not only the general, but the particular cauſes.

and, in ſhort, the whole contrivance either of that admirable engine, or ſome other capable to perform the ſame things.

Nay, a lover of diſputing would proceed farther, and queſtion that way of reaſoning, which even the eminenteſt atomiſts are wont to imploy to demonſtrate, that they explicate things aright.

Some defects in the ways of reaſoning uſed by the moſt eminent atomiſts.

For the grand argument, by which they uſe to confirm the truth of their explications, is, that either the phænomenon muſt be explicated after the manner by them ſpecified, or elſe it cannot at all be explicated intelligibly: in what ſenſe we diſallow not, but rather approve this kind of ratiocination, we may elſewhere tell you. But that, which is in this place more fit to be repreſented, is, that this way of arguing ſeems not in our preſent caſe ſo cogent, as they, that are wont to employ it, think it to be: for beſides, that it is bold to affirm, and hard to prove, that what they cannot yet explicate by their principles, cannot poſſibly be explicated by any other men, or any other philoſophy; beſides this, I ſay, that which they would reduce their adverſaries to, as an abſurdity, ſeems not to deſerve that name. For ſuppoſing the argument to be concluſive, that either the propoſed explication muſt be allowed, or men can give none at all, that is intelligible; I ſee not what abſurdity it were to admit of the conſequence. For who has demonſtrated to us, that men muſt be able to explicate all nature's phænomena, eſpecially ſince divers of them are ſo abſtruſe, that even the learnedeſt atomiſts ſcruple not to acknowledge their being unable to give an account of them. And how will it be proved, that the omniſcient God, or that admirable contriver, Nature, can exhibit phænomena by no ways, but ſuch as are explicable by the dim reaſon of man? I ſay explicable, rather than intelligible; becauſe there may be things, which though we might underſtand well enough, if God, or ſome more intelligent being than our own, did make it his work to inform us of them, yet we ſhould never of our ſelves find out thoſe truths. As an ordinary watch-maker may be able to underſtand the curiouſeſt contrivance of the ſkilfulleſt artificer, if this man take care to explain his engine to him, but would never have underſtood it, if he had not been taught: whereas to explicate the nature and cauſes of the phænomena we are ſpeaking of, we muſt not only be able to underſtand, but to inveſtigate them.

And whereas, it is peremptorily inſiſted on by ſome Epicureans, who thereby pretend to demonſtrate the excellency and certainty of their explications, that, according to them, nature is declared to produce things, in the way that is moſt facile and agreeable to our reaſon: it may be replied, that what we are to inquire after, is, how things have been, or are really produced; not whether or no the manner of their production be ſuch, as may the moſt eaſily be underſtood by us: for if all things were, as thoſe we reaſon withal maintain, caſually produced, there is no reaſon to imagine, that chance conſidered what manner of their production would be the moſt eaſily intelligible to us. And if God be allowed to be, as indeed he is, the author of the univerſe, how will it appear that he, whoſe knowledge infinitely tranſcends ours, and who may be ſuppoſed to operate according to the dictates of his own immenſe wiſdom, ſhould, in his creating of things, have reſpect to the meaſure and eaſe of human underſtandings; and not rather, if of any, of angelical intellects? So that whether it be to God or to chance, that we aſcribe the production of things, that way may often be fitteſt or likelieſt for nature to work by, which is not eaſieſt for us to underſtand.

And as for the way of arguing, ſo often imployed (eſpecially againſt the truth we now contend for) and ſo much relied on by many modern philoſophers, namely, that they cannot clearly conceive ſuch or ſuch a thing propoſed, and therefore think it fit to be rejected; I ſhall readily agree with them, in the not being forward to aſſent to any thing, eſpecially in philoſophy, that cannot well be conceived by knowing and conſidering men. But there is ſo much difference among men, as to their faculty of framing diſtinct notions of things, and through men's partiality or lazineſs, many a particular perſon is ſo much more apt, than theſe men ſeem to be aware of, to think, or at leaſt to pretend, that he cannot conceive, what he has no mind to aſſent to, that a man had need be wary, how he rejects opinions, that are impugned only by this way of ratiocination: by which, I hope, it will not be expected, that we ſhould be more prevailed with, than that ſect of philoſophers that imploys it moſt. And among thoſe, that reſolve the phænomena of nature into the mechanical powers of things, or the various figures, ſizes and motions of the parts of matter, I meet with ſome, as the Epicureans, who tell us, they cannot frame a notion of an incorporeal ſubſtance or ſpirit, nor conceive how, if the ſoul were ſuch, it could act upon the body: and yet others, that ſeem no leſs ſpeculative, ſeriouſly and ſolemnly profeſs, that they can conceive a clear and diſtinct notion of a ſpirit, which they believe the human ſoul, that regulates at leaſt, if not produces divers motions of the body, to be; denying on the other ſide, that it can be clearly conceived, either that any thing, that is only material, can think, or that there can poſſibly be any vacuum (that is, place without any body) in the univerſe; both which the Epicureans profeſs themſelves not only to conceive as poſſible, but believe as true.

AND thus much, *Pyrophilus*, it may ſuffice to have ſaid in relation to thoſe, who would reject God from having any thing to do, either in the production or government of the world, upon this ground, that they, if you will believe them, can explicate the original and phænomena of it without him; but it is not all, nor the greateſt part of the favourers of the atomical philoſophy, that preſume ſo much of themſelves, and derogate ſo much from God. To ſay therefore ſomething to the more moderate and judicious of that perſuaſion, we will candidly propoſe on their behalf the moſt plauſible objection we can foreſee, againſt the truth we have been all this while pleading for. They may then thus argue againſt us, that though the atomiſts cannot ſufficiently demonſtrate from what natural cauſes every particular effect proceeds, and ſatisfactorily explicate after what determinate manner each particular phænomenon is produced; yet it may ſuffice to take away the neceſſity of having recourſe to a Deity, that they can make out in general, that all the things, that appear in the world, may, and muſt be performed by meerly corporeal agents; or, if you pleaſe, that all nature's phænomena may be produced by the parcels of the great maſs of univerſal matter, variouſly ſhaped, connected, and moved. As a man, that ſees a ſcrewed gun ſhot off, though he may not be able to deſcribe the number, bigneſs, ſhape, and co-aptation of all the pieces of the lock, ſtock, and barrel, yet he may readily conceive, that the effects of the gun, how wonderful ſoever they may ſeem, may be performed by certain pieces of ſteel, of iron, and ſome parcels of wood, of gunpowder, and of lead, all faſhioned and put together according to the exigency of the engine; and will not doubt, but that they are produced by the power of ſome ſuch mechanical contrivance of things purely corporeal, without the aſſiſtance of ſpiritual or ſupernatural agents.

The moſt plauſible argument of the oppoſers of a Deity conſidered.

IN anſwer to this objection, I muſt firſt profeſs to you, that I make great doubt, whether there be not ſome phænomena in nature, which the atomiſts cannot ſatisfactorily explain by any figuration, motion, or connection of material particles whatſoever: for ſome faculties and operations of the reaſonable ſoul in man are of ſo peculiar and tranſcendent a kind, that as I have not yet found them ſolidly explicated by corporeal principles, ſo I expect not to ſee them in haſte made out by ſuch. And if a ſpiritual ſubſtance be admitted to enter the compoſition of and to act by and upon his body; beſides that one of the chief and fundamental doctrines of the Epicureans (namely, that there is nothing in the univerſe but *corpus* and *inane*) will thereby be ſubverted,

verted, it will appear, that an incorporeal and intelligent being may work upon matter, which would argue, at leaſt a poſſibility, that there may be a ſpiritual Deity, and that he may intermeddle with, and have an influence upon the operations of things corporeal. But to inſiſt no longer on this, let us give a further and direct anſwer to the propoſed objection, by repreſenting, that although as things are now eſtabliſhed in the world, an atomiſt were able to explain the phænomena we meet with, by ſuppoſing the parts of matter to be of ſuch ſizes, and ſuch ſhapes, and to be moved after ſuch a manner, as is agreeable to the nature of the particular phænomenon to be thereby exhibited; yet it would not thence neceſſarily follow, that, at the firſt production of the world, there was no need of a moſt powerful and intelligent being, to diſpoſe that chaos or confuſed heap of numberleſs atoms into the world, to eſtabliſh the univerſal and conſpiring harmony of things; and eſpecially to connect thoſe atoms into ſuch various ſeminal contextures, upon which moſt of the more abſtruſe operations, and elaborate productions of nature appear to depend. For many things may be performed by matter variouſly figured and moved, which yet would never be performed by it, if it had been ſtill left to it ſelf without being, at firſt at leaſt, faſhioned after ſuch a manner, and put into ſuch a motion by an intelligent agent. As the quill, that a philoſopher writes with, being dipt in ink, and then moved after ſuch and ſuch a manner upon white paper, all which are corporeal things, or their motions, may very well trace an excellent and rational diſcourſe; but the quill would never have been moved after the requiſite manner upon the paper, had not its motion been guided and regulated by the underſtanding of the writer. Or rather, yet once more, to reſume our former example of the *Straſburg*-clock; though a ſkilful artiſt, admitted to examine and conſider it, both without and within, may very well diſcern, that ſuch wheels, ſprings, weights, and other pieces, of which the engine conſiſts, being ſet together in ſuch a coaptation, are ſufficient to produce ſuch and ſuch motions, and ſuch other effects as that clock is celebrated for; yet the more he diſcerns the aptneſs and ſufficiency of the parts to produce the effects emergent from them, the leſs he will be apt to ſuſpect, that ſo curious an engine was produced by any caſual concurrence of the parts it conſiſts of, and not rather by the ſkill of an intelligent and ingenious contriver; or that the wheels, and other parts, were of this or that ſize, or this or that determinate ſhape, for any other reaſon, than becauſe it pleaſed the artificer to make them ſo: though the reaſon, that moved the artificer to employ ſuch figures and quantities ſooner than others, may well be ſuppoſed to have been, that the nature of his deſign made him think it very proper and commodious for its accompliſhment, if not better than any other ſuited to the ſeveral exigencies of it.

If an Epicurean ſhould be told, that a man, after having been for ſome days really dead, became alive again, I think it will not be doubted, but that he would reject ſuch a relation as impoſſible, and therefore too manifeſtly falſe to be believed by any man in his wits: and yet, according to his principles, the man, as well ſoul as body, conſiſted only of divers particles of the univerſal matter, by various motions brought together, and diſpoſed after a certain manner: and conſequently, he muſt ground his perſuaſion, that it is impoſſible to redintegrate the engine once ſpoiled by death, upon this, that as chance cannot with the leaſt probability be preſumed to have produced ſuch a ſtrange effect; ſo, according to him, there can be no cauſe aſſigned, knowing and powerful enough to rally and bring together again the diſbanded and ſcattered parcels of matter (or ſubſtitute other equivalent ones) that, together with the remaining carcaſs, compoſed the dead man, ſo to re-unite them to the reſt; and laſtly, ſo to place and put into motion both the one and the other, as were requiſite to make a living man once more reſult from them. I know, that this example reaches not all the circumſtances of the controverſy we have been debating; but yet, if I miſtake not, it will ſerve the turn, for which I propoſe it. For, not now to inſiſt upon this inference from it, That a conſidering man may confidently reject a thing, that is not abſolutely impoſſible, provided it be highly incredible; not to inſiſt on this, I ſay, the thing I aim at in the mention of it, is only to ſhew, that ſuch things may poſſibly be effected by matter and motion, as no wiſe man will believe to have been produced by a bare agitation of the particles of matter, not guided by the ſuperintendency of a powerful and knowing Director.

Now that the atoms, or particles of matter, of which the world conſiſts, made no agreement with each other to convene and ſettle in the manner requiſite to conſtitute the univerſe, *Lucretius* does not ſo properly confeſs, as affirm, in that fore-cited paſſage, where he judiciouſly tells us, that

*—Certè neque conſiliis primordia rerum*
*Ordine ſe quæque, atque ſagaci mente locarunt:*
*Nec quos quæque darent motus pepigêre profectò.*

And the thing it ſelf is manifeſt enough, from the nature of atoms confeſſedly inanimate and devoid of underſtanding.

So that although we ſhould grant, *Pyrophilus*, the poſſible emergency of the innumerable effects we admire in the world, from the various properties and coalitions of atoms, yet ſtill you ſee the formerly mentioned difficulty (touching the reſulting of all things from matter left to it ſelf) would recur; and it would as well be incredible, that an innumerable multitude of inſenſible particles, as that a leſſer number of bigger parcels of matter, ſhould either conſpire to conſtitute, or fortuitouſly juſtle themſelves into ſo admirable and harmonious a fabrick as the univerſe, or as the body of man; and conſequently it is not credible, that they ſhould conſtitute either, unleſs as their motions were (at leaſt, in order to their ſeminal contextures and primary coalitions) regulated and guided by an intelligent contriver and orderer of things. And I ſhould ſo little think it a diſparagement to have but ſo much ſaid of any hypotheſis of mine, that I ſuppoſe I may affirm it, without offending either the moſt ſober, or the generality of the atomical philoſophers, to whom, and to their doctrine, my writings will manifeſt to be no otherwiſe affected than I ought.

## ESSAY V.

### *Wherein the Diſcourſe, interrupted by the late Digreſſion, is reſumed and concluded.*

IT remains now, *Pyrophilus*, that we at length return into the way from whence the foregoing digreſſion has, I fear, too long diverted us; and that to proſecute and finiſh our diſcourſe, we take it up where we left it, and were tempted to digreſs; namely, at the third eſſay; betwixt which, and the beginning of this fifth, all that has been interpoſed may be looked upon but as a long parentheſis.

In the third place then I conſider, that whether or no it be true, which our antagoniſts ſuggeſt, that there are ſome things in nature, which tempt philoſophers more than they do the vulgar, to doubt or deny a God; yet certainly there are divers things

**That there are ſome things in nature, which conduce much to the evincing of a Deity, which are only well known to naturaliſts.**

**Explained by the compariſon of the uniting ſcattered pieces of paint into one face by a cylindrical looking glaſs.**

**The teſtimony of the author of the book de Mundo, aſcribed to *Ariſtotle*, introduced.**

*Ariſt.* de Mundo, cap. 6.

Ibidem.

in nature, that do much conduce to the evincing of a Deity, which naturaliſts either alone diſcern, or at leaſt diſcern them better than other men. For beſides the abſtruſe properties of particular bodies, not diſcovered by any but thoſe, that make particular inquiries into thoſe bodies, there are many things in nature, which to a ſuperficial obſerver ſeem to have no relation to one another; whereas to a knowing naturaliſt, that is able to diſcern their ſecret correſpondencies and alliances, theſe things, which ſeem to be altogether irrelative each to other, appear ſo proportionate and ſo harmonious both betwixt themſelves, and in reference to the univerſe they are parts of, that they repreſent to him a very differing and incomparably better proſpect than to another man: as he, that looks upon a picture made up of ſcattered and deformed pieces, beholding them united into one face by a cylindrical looking glaſs aptly placed, diſcerns the ſkill of the artiſt, that drew it, better than he, that looks only on the ſingle parts of that picture, or upon the whole picture, without the uniting cylinder. Which brings into my mind, that whereas in the ſacred ſtory of the creation, when mention is made of God's having conſidered the works of each of the firſt ſix days, at the end of it, it is ſaid of the work of every day, *That God ſaw, that it was good*, (except of the ſecond day, becauſe the ſeparation of the waters was but imperfectly made on that day, and compleated in the next, on which it is therefore twice ſaid, *That God ſaw, that it was good*;) whereas, I ſay, when God looked upon his works in particular, it is only ſaid, *That he ſaw, that they were good:* when he is introduced at the cloſe of the creation, as looking upon, and ſurveying his creatures in their harmony, and entire ſyſtem, it is emphatically ſaid, *That he ſaw every thing, that he had made, and behold it was very good.* And if *Ariſtotle* be indeed the author of the book *De Mundo ad Alexandrum*, which paſſes for his, and is ſaid to have been written by him towards the end of his life, it would not be unworthy our obſervation to take notice, how he, that in his other writings is wont to talk of God's intereſt in the creatures darkly, and heſitantly enough, is wrought upon by the contemplation of the univerſe, as it is an orderly aggregate or ſyſtem of the works of nature, to make expreſſions of the divine architect, which are not unworthy of *Ariſtotle*, though, being meerly human, they cannot be worthy of God. Amongſt many, I ſhall ſingle out ſome; and I hope, *Pyrophilus*, you will excuſe me, if in this eſſay, and ſome of the precedent ones, I do, contrary to my cuſtom, employ pretty ſtore of paſſages taken out of other authors. For firſt, the nature of my deſign makes it requiſite for me to ſhew, what opinion the heathen philoſophers had of the ſtudy of phyſiology, and what power their contemplation of nature had to ingage them to acts of religion. And next, ſince divers of the ſame paſſages, wherein they had ſet down their opinions, contained alſo the grounds and reaſons of them, whereby they have anticipated much of what we ſhould ſay upon the ſame ſubjects; I was unwilling to deprive you of their pertinent ratiocinations, or rob them of the glory of what they had well written. And this neceſſary apology premiſed, let us proceed to conſider his paſſages; and firſt, *Reſtat* (ſays he) *ut ſummatim de cauſa diſſeramus, quæ cunctarum ipſa rerum vim habet tutricem & continentem, quemadmodum cætera perſtrinximus: flagitii enim inſtar eſſet, cum de mundo dicere inſtituerim, tractatu ſi minus exquiſito fortaſſe, at certè qui ſat eſſe poſſit ad formulam doctrinæ craſſiorem, intactam præcipuam mundi partem principemque præterire.* ‘It remains, that we ſpeak briefly concerning that cauſe, whoſe power preſerves and ſupports all things, in like manner, as we have compendiouſly handled other matters. For it would ſeem criminal to paſs over the chief part of the world untouched, having deſigned to diſcourſe of the univerſe in a treatiſe, which, if leſs accurate, yet certainly may be ſufficient for a rough platform of doctrine.’ And a little after, *Etenim* (ſays he) *cunctarum quæ rerum natura complectitur, cum ſervator eſt Deus, tum vero quæcunque in hoc mundo quoquomodo perficiuntur, eorum omnium idem eſt genitor:*

Eodem Cap.

Eodem Cap.

Of the admirable contrivance of the make of the muſculus marſupialis.

*genitor: non ſic tamen ipſe ut opificis in morem, animaliſque laſſitudinem ſentientis labore affici poſſit, ut qui ea facultate utatur, quæ nulli cedat difficultati, cujus ipſe vi facultatis omnia in poteſtate continet, nec minus etiam quæ longius ab ipſo videntur eſſe ſummota:* ‘For God is both the preſerver of all things contained in the univerſe, and likewiſe the producer of every thing whatſoever, which is in any wiſe made in this world: yet not ſo as to be ſenſible of labour; after the manner of a workman, or a creature, which is ſubject to wearineſs: for he is endued with a power, which is inferiour to no difficulty, and whereby he contains all things under his authority, even ſuch as ſeem moſt diſtant from him.’ To which purpoſe he elſewhere ſays, *Auguſtius decentiuſque exiſtimandum eſt, Deum ſummo in loco ita eſſe collocatum; numinis ut tamen ejus vis per univerſum mundum pertingens, tum ſolem, lunamque moveat, tum cælum omne circumagat, ſimulque cauſam præbeat eorum, quæ in terra ſunt ſalutis atque incolumitatis:* ‘It is more magnificent and agreeable to conceive God ſo reſident in the higheſt place, that nevertheleſs his divine energy being diffuſed throughout the whole world, moves both the ſun and moon, turns round the whole globe of heaven, and affords the cauſes of ſafety and preſervation of ſuch things as are upon the earth.’ And in the ſame book he adds, *Ut vero ſummatim loquamur, quod in navi gubernator eſt, quod in curru agitator, quod in choro præcentor, quod denique lex in civitate, & dux in exercitu, hoc Deus eſt in mundo. Niſi ſi hactenus intereſt quod labor, & motus multiplex illos exercet & curæ angunt variæ, cum huic illaborata ſuccedunt omnia, omnis moleſtiæ expertia:* ‘But to ſum up all in brief; what the pilot is in a ſhip, what the driver in a chariot, what the chief ſinger is in a dance; finally, what magiſtracy is in a commonwealth, and the general in an army, that is God in the world: unleſs there be this difference, that much toil and manifold cares perplex them, but all things are performed by God without labour or trouble.’ And certainly he, that is a ſtranger to anatomy, ſhall never be able to diſcern in the circulation of the blood, the motion of the chyle, and the contrivance of all the parts of a human body, thoſe proofs, as well as effects, of an omniſcient Δημιȣργος, or artiſt, which a curious anatomiſt will diſcover in that elaborate and matchleſs engine: as I remember, I had occaſion not long ſince to take notice of in the ſhape of that ſtrange muſcle (the *obturator internus*) which ſome call from its figure *marſupialis*, ſerving to the motion of the thigh. For this muſcle ſeems ſo made, as if nature had deſigned in it to manifeſt, that ſhe is ſkilled in the mechanicks, not only as a mathematician, that underſtands the powers of diſtance, weight, proportion, motion and figure; but as an artificer, or handycrafts man, who knows by dextrous contrivances to furniſh the more endangered parts of his work, with what is more uſeful to make it laſting; there being (to omit other obſervables, belonging to that muſcle) a deep notch made in the coxendix, to ſhorten the way betwixt the two extremities of the muſcle, and make it bear upon the bone with a blunter angle. And becauſe the tendon is long, leſt, notwithſtanding the former proviſion, it ſhould be apt to fret out upon the edge of the bone, nature has provided for it a muſculous piece of fleſh, wherein it is as it were ſheathed, that ſo it might not immediately bear, and grate upon the bone; juſt as our artificers uſe to ſew caſes of leather upon thoſe parts of ſilken ſtrings, which being to grate upon harder bodies, were otherwiſe endangered to be fretted out by attrition.

And of the parts of the hand.

AND a like ſkilfulneſs of nature in the mechanical contrivance of the parts, is more obviouſly diſcernible in the ſtructure of that admirable engine, by which ſuch variety of other engines are made, the hand: where (not to mention the *ligamentum latum*, or wriſt-band, that keeps the tendons, that move under it, from inconveniently ſtarting up upon the contraction of the reſpective muſcles) the wonderful perforations, that are made through the tendons of the *muſculi perforati* by thoſe of the *muſculi perforantes*, for the more commodious motion of the joints of the fingers, may conſpicuouſly manifeſt

The contrivance for the circulation of the blood in a fœtus before the uſe of reſpiration.

the mechanical dexterity of nature; as it may her huſbanding (if I may ſo ſpeak) of her work, that in a fœtus, whilſt it lies in the womb, becauſe the lungs are not to be diſplayed as afterwards, and ſo the blood needs not circulate thorough them, from the right ventricle of the heart into the left, for the uſe of reſpiration, as it muſt in grown animals, ſhe contrives a nearer way; and by certain ſhort pipes, peculiar to ſuch young creatures, ſhe more commodiouſly performs in them the circulation of the blood, proportioned to their preſent condition; and afterwards, when the animal is brought out of the womb into the open air, and put upon the conſtant exerciſe of his lungs, theſe temporary conduit-pipes, little by little, vaniſh. So careful is nature not to do things in vain.

*Galen*'s ſpeech, that his books de Uſu Partium were as hymns to the Creator. *Galenus* lib. 30. De Uſu Partium. The fabrick of the eye conſidered.

AND therefore I do not much wonder, that *Galen*, though I remember he ſomewhere (unprovokedly and cauſeleſly enough) derides *Moſes*, and ſeems not over-much inclined to make religious acknowledgements; yet when he comes to conſider particularly the exquiſite ſtructure of a human body, ſhould break forth into very elevated, and even pathetical celebrations of God, and tell us, that in his books, *De Uſu Partium*, he compoſed hymns to the Creator's praiſe. And certainly he, that ſhall ſee a ſkilful anatomiſt dextrouſly diſſect that admirable part of man, the eye, and ſhall conſider the curious contrivance of the ſeveral coats, humors, and other parts it conſiſts of, with all their adaptations and uſes, would be eaſily perſuaded, that a good anatomiſt has much ſtronger invitations to believe, and admire an omniſcient Author of nature, than he, that never ſaw a diſſection; eſpecially if he ſhould ſee how all of theſe concur to make up one optical inſtrument, to convey the ſpecies of the viſible object to the optick nerve, and ſo to the brain; as I have with pleaſure conſidered it, in the recent eye of a cat (for with keeping it will grow flaccid) cut cleanly off, where the optick nerve enters the ſclerotis, and is going to expand itſelf into the retina; for holding this eye at a convenient diſtance betwixt yours and a candle, you may ſee the image of a flame lively expreſſed upon that part of the back ſide of the eye, at which the optick nerve enters the above mentioned ſclerotis. Something of this kind we have alſo ſhown our friends with eyes of dead men, carefully ſever'd from their heads; and with the (dexterouſly taken out) cryſtalline humour of a human eye, we have often read, as with a lens or magnifying glaſs. And to aſſiſt you in ſo pleaſing a ſpeculation, as that of the eye, we ſhall add, that by reaſon ox eyes are much larger, and eaſier to be had than human ones, we are wont to make much uſe of them, and to diſcern ſome things better in their coats, we immerſe them for a little while in boiling water; and to be able to conſider the form and bigneſs of the vitreous and cryſtalline humours, better than the fluidity of the one, and the ſoftneſs of the other are wont to allow anatomiſts to do; we have ſometimes, by a way hereafter to be ſet down, ſpeedily frozen eyes, and thereby have turned the vitreous humour into very numerous and diaphanous films (as it were of ice, and the cryſtalline into a firm ſubſtance) but (which perhaps you will wonder at) not tranſparent. An eye thus frozen may be cut along that, which optical writers call the optical axis, and then it affords an inſtructive proſpect, which we have not been able to obtain any other way. But becauſe, notwithſtanding this expedient in the eyes of men, and the generality of terreſtrial animals, the opacouſneſs of the ſclerotis hinders the pictures, that outward objects (unleſs they be lucid ones) make within the eye to be clearly diſcerned; we think our ſelves obliged to that excellent mathematician of your acquaintance, *Pyrophilus*, who, upon ſome diſcourſe we had with him concerning this ſubject, lately adviſed us to make uſe of the eyes of white rabbits (for if thoſe animals be of another colour, he ſays, their eyes will not prove ſo fit for our purpoſe.) For having held ſome of theſe eyes at a convenient diſtance betwixt my eyes and the window, I found them to be ſo tranſparent, that the rays proceeding

Some experimental obſervations of the eye, and uſe of its parts in order to viſion.

The way to prepare the eyes of animals for the better making obſervations on them.

Some particulars wherein the eyes of white rabbits are better than others for obſervation.

ceeding from the panes of glaſs, iron bars, *&c.* of the window, paſſing through the cryſtalline humour and in their paſſage refracted, did on the retina, exhibit in an inverted poſture, according to the optical laws, the contracted, but lively pictures of thoſe external objects; and thoſe pictures, by reaſon of the tranſparency of the ſclerotis, became viſible through it to my attentive eyes: as in a darkened room the ſhadows of objects without it, projected on a fine ſheet of paper, may, by reaſon of the thinneſs of paper, be ſeen thorough it by thoſe that ſtand behind it. By candle-light we could ſee little in the bottom of theſe eyes but lucid objects, ſuch as the flame of the candle, which appeared tremulous, though inverted; but by day-light we could manifeſtly diſcern in them, both the motions of very neighbouring objects, and the more vivid of their colours.

That it is diſhonourable for the ſoul to be unacquainted with the exquiſite ſtructure of the body, being its own manſion.

*Pſal.* cxxxix. 14, 15, 16.

Proved out of inſtances in the Pſalmiſt and *Galen*.

*Galen* de plac. Hip. & Plat. lib. 7.

AND really, *Pyrophilus*, it ſeems to me, not only highly diſhonourable for a reaſonable ſoul to live in ſo divinely built a manſion, as the body ſhe reſides in, altogether unacquainted with the exquiſite ſtructure of it; but I am confident, it is a great obſtacle to our rendering God the praiſes due to him, for his having ſo excellently lodged us, that we are ſo ignorant of the curious workmanſhip of the manſions our ſouls live in: for not only the Pſalmiſt, from the conſideration of the divine art diſplayed by God, in the moulding and faſhioning his body in the womb, takes a juſt occaſion to celebrate his Maker, *I will praiſe thee* (ſays he) *becauſe I am fearfully and wonderfully made. Marvellous are thy works, and that my ſoul knoweth right well: my ſubſtance was not hid from thee, when I was made in ſecret, and curiouſly wrought,* (with as much curioſity as tapeſtry or embroidery, as the Hebrew *Rukkamti* ſeems to import.) *In the loweſt parts of the earth thine eyes did ſee my ſubſtance, yet being unperfect; and in thy book all my members were written, which in continuance were faſhioned, when as yet there were none of them.* But even from *Galen* himſelf anatomical reflections have been able to extort expreſſions of devotion: *Cum igitur* (ſays he) *quod in omnibus recte fit, omnes ad artem referunt, quod autem in uno, aut duobus non ad artem, ſed fortunam; merito ex noſtri ſtructura corporis licet admirari ſummam artem, æquitatem & vim naturæ quæ nos conſtruxit. Conſtat ſiquidem corpus noſtrum ex oſſibus pluribus quam ducentis, ad ſingula oſſa vero pervenit nutriens vena; ſicut ad muſculos: cum hâc etiam arteria & nervi; pariaque adamuſſim ſunt, & omnino ſimilia in dextra animantis ſita, iis quæ in altera ſunt; os oſſi, muſculus muſculo, vena venæ, arteria arteriæ, ac nervus nervo; idque exceptis viſceribus, atque nonnullis particulis, quæ habere propriam deſcriptionem videntur. Duplices itaque corporis noſtri partes, omnino inter ſe ſunt ſimiles & magnitudine & conformatione, ſicuti & conſiſtentia quam voco juxta mollitiem, duritiemque differentia. Quemadmodum igitur de humanis effectibus judicium faciamus, ex navi ſumma arte conſtructa cognoſcentes peritiam artificis, ita etiam de Divinis facere convenit, corporiſque noſtri opificem admirari, quicunque tandem is deorum exiſtat, etiamſi eum non videmus:* 'Whereas therefore (ſaith he) all men aſcribe that to art, which is made aright in all reſpects, but that, which is only in one or two, not to art, but fortune; the ſtructure of our body gives us cauſe to admire the excellent art, exactneſs, and power of nature, which framed us. For our body conſiſts of above two hundred bones; to each of which tends a vein for conveying of nouriſhment (in like manner as to the muſcles) which is accompanied with an artery and a nerve; and the parts are exactly pairs, and thoſe placed in the right ſide of an animal are wholly alike to thoſe in the other, bone to bone, muſcle to muſcle, vein to vein, artery to artery, and nerve to nerve; excepting only the bowels, and ſome other parts, which ſeem to have a peculiar conſtruction. So that the parts of our body are double, and altogether alike among themſelves, both in greatneſs and ſhape, as alſo in conſiſtence, which I place in the diverſity of ſoftneſs and hardneſs. As therefore we uſe to judge of things made by men, acknow-

'ledging the ſkill of a workman, by the building of a ſhip with extraordinary art; 'ſo alſo it behoveth to do in thoſe of God, and to admire the framer of our body, 'whoſoever of the gods he were, although we do not ſee him.'

PERHAPS it may be truly ſaid yet further, that although in human bodies, many wonders, as we have lately mentioned, have been diſcovered to us by anatomy, yet anatomy it ſelf has not diſcovered to us all the wonders to be met with in a human body, nor will detect them, till anatomiſts be ſkilled in ſome other things over and above that of dexterouſly diſſecting. For it ſeems very probable, that the excellent contrivance of ſome parts will never be fully apprehended, without a competent knowledge of the nature of thoſe juices, that are to paſs thorough them, and ſome of them receive their beginning, or ſome alteration, in them; and the nature of theſe juices will ſcarce be exactly known, without ſome ſkill in divers parts of phyſiology, and eſpecially in chymiſtry. Beſides, the reaſon of the origination, ſhape, bulk, length, progreſs, and inſertion of each particular muſcle, can hardly be well accounted for without ſome ſkill in the principles of mechanicks, and in the nature and properties of leavers, pulleys, *&c.* Moreover, there is a certain harmonious proportion betwixt the parts of a human body, in reference both to the whole, and to one another, which is not wont to be heeded by anatomiſts, but much taken notice of by ſtatuaries and painters. For they reckon, that when a man's arms are diſplayed, the diſtance betwixt his middle fingers is equal to the height of his body; ſo they reckon ſometimes ſeven, ſometimes eight lengths of the head, to the length of the body; and four times the length of the noſe to that of the head, as three times the ſame length to that of the face. And divers ſuch obſervations we have met with among them, which we ſhall not now inſiſt on, but rather tell you, that without ſome ſkill in opticks, it will be hard for an anatomiſt to ſhew the wiſdom of God in making the cryſtalline humour of the eyes of men only of a ſomewhat convex or lenticular form, rather than as thoſe of fiſhes of an almoſt perfectly ſpherical one, (as to the anterior part, which is obverted to the outward objects.) Nor do I remember, that in anatomy ſchools I have heard any account given of this difference, which yet tends much to manifeſt the wiſdom of the author of nature, who has ſo excellently ſuited the eyes of animals to the ſeveral parts of the univerſe he deſigned them to inhabit. For men, and other terreſtrial animals living in the air, the beams of light, reflected from viſible objects, and falling over the cornea, and the aqueous humour, do neceſſarily ſuffer a refraction there, as coming from the air, which is a thinner medium, into a thicker, and ſo there needs the leſs of farther refraction to be made by the cryſtalline humour, and conſequently its figure needs to be but moderately convex: whereas fiſhes living conſtantly in the water, the medium, through which they ſee things, is almoſt of a like thickneſs with the cornea and aqueous humour; ſo that there being little or no refraction made in their eyes but by the cryſtalline it ſelf, it was neceſſary, that it ſhould be exceedingly convex, that it might make a very great refraction, and thereby unite the beams nearer at hand; which, if the cryſtalline were leſs convex, would tend to a point of concourſe beyond the retina, and conſequently paint on it but a languid and confuſed picture of the object they ſhould repreſent.

Why the anterior part of fiſhes eyes ought to be more ſpherical than thoſe of men.

As for *Paracelſus*, certainly he is injurious to man, if (as ſome eminent chymiſts expound him) he calls man a microcoſm, becauſe his body is really made up of all the ſeveral kinds of creatures the macrocoſm or greater world conſiſts of, and ſo is but a model or epitome of the univerſe: for (to omit, that the ancients, as *Galen* informs us, gave the title of microcoſms to animals in general) it is the glory and prerogative of man, that God was pleaſed to make him, not after the world's image, but his own. On which occaſion give me leave to tell you, that however the conſideration

That God made man not after the world's image, but his own.

Lib. 3. De Uſu Part.

deration of the dignity conferred on us in the image of God, (in whatever that image be reſolved to conſiſt) ſhould, methinks, be ſome engagement to us to look upon our ſelves as belonging unto God; as our Saviour, from the image of *Cæſar* ſtampt upon a coin, pronounced it fit to render unto *Cæſar* the things of *Cæſar*, and to God thoſe of God.

That the image of God on us ſhould engage us to eſteem ourſelves as belonging to God.

IN the fourth place, I conſider, that the univerſal experience of all ages manifeſts, that the contemplation of the world has been much more prevalent to make thoſe, that have addicted themſelves to it, believers, than deniers of a Deity. For it is very apparent, that the old philoſophers, for the moſt part, acknowledged a God; and as evident it is, by their want of revelation, by many paſſages in their writings, and by divers other things not now to be inſiſted on, that the conſideration of the works of nature was the chief thing, that induced them to acknowledge a divine author of them. This truth I could eaſily make out, were I at leiſure to tranſcribe teſtimonies, which, becauſe I am not, I ſhall content my ſelf to mention to you one, which may well ſerve for many, it being a confeſſion made by *Ariſtotle*, or whatever other learned philoſopher it was, who writ the book *de Mundo*, that God's being the architect and upholder of the world was the general belief of the ages, that preceded his. *Vetus* (ſays he) *ſermo eſt à majoribus proditus, inter omnes homines, univerſa tum ex Deo tum per Deum conſtituta fuiſſe atque coagmentata, nullamque naturam ſatis inſtructam ad ſalutem eſſe poſſe, quæ citra Dei præſidium, ſuæ ipſa demum tutelæ permiſſa ſit:* 'It is an ancient tradition (ſaith he) diffuſed amongſt all mankind from our anceſtors, that all things were made and produced of God, and by God; and that no nature can be ſufficiently furniſhed for its own ſafety, which is left without the ſupport of God, to its own protection.' And as for both the opinion of that eminent author himſelf, and the grounds of it, he ſpeaks of God and the creation almoſt in the terms of St. *Paul*: *Proinde* (ſays he) *hæc etiam de Deo ſentienda nobis ſunt, illo quidem, ſi vim ſpectes, valentiſſimo; ſi decorem, formoſiſſimo; ſi vitam, immortali; denique, ſi virtutem, præſtantiſſimo. Quapropter cum ſit inconſpicabilis naturæ omni interituræ, ipſis nihilominus ipſe cernitur ab operibus, atque ea quidem quæ aëre quoquo modo affecto, quæ in terra, quæ in aqua, ea certè Dei opera eſſe meritò dixerimus: Dei inquam opera, cum imperio ſummo mundum, ac pro poteſtate obtinentis, ex quo Deo, ut inquit Empedocles phyſicus:*

Arguments from authority, and the experience of all ages, that the contemplation of the world has addicted man to the reverence of God.

Libro De Mundo, cap. 6.

Alibi eodem c.

*Omnia quotquot erunt, quot ſunt præſentia, quotque*
*Orta fuere antehac ſtirpes, hominesque feræque,*
*Indè etiam volucres, piſceſque humoris alumni.*

'Thus therefore we ought to conceive of God: if we conſider his power, he is omnipotent; if his ſhape, moſt beautiful; if his life, immortal; and finally, if his virtue, moſt excellent. Wherefore though undiſcernable by any corruptible nature, yet he is perceived by ſuch in his works; and indeed thoſe things, which are produced in the air, by any mutation whatſoever, in the earth, or in the water, we ought deſervedly to term the works of God; which God is the abſolute and ſovereign Lord of the world, and out of whom (as ſaith *Empedocles* the naturaliſt,)

*All things beginning have, which e'er ſhall be,*
*Are preſent or to come, plants, men, and beaſts,*
*And fowl, and fiſh the off-ſpring of the ſea.*

AND thoſe few philoſophers (if ever there have been any at all) that have been really atheiſts, are no ways conſiderable for their number, in reſpect of thoſe, that have aſſerted a Deity; and their paradoxes have been looked upon as ſo irrational, that, as ſoon as they have been propoſed, they have been diſdainfully rejected and condemned by all the reſt of mankind, who have looked upon the patrons of them as monſters, rather than philoſophers. And if there be, at this day, any nations (as navigators inform us there are in *Braſil*, and ſome other parts of the *Indies)* that worſhip no God, they conſiſt not of naturaliſts, but brute, and irrational barbarians, who may be ſuppoſed rather to ignore the being of God, than deny it; and who, at leaſt, are little leſs ſtrangers to the myſteries of nature, than to the author of it. And if it be a truth, that there are really ſuch atheiſtical people, it may ſerve to recommend to us the ſtudy of phyſiology, by ſhewing us, that without the help of any ſuch innate belief, or perſuaſion of a God, as is ſuppoſed connatural to man, reaſon exerciſed upon the objects the creation preſents us with, is ſufficient to convince philoſophers of a Deity. And indeed ſuch a care has God taken, to make his being conſpicuous in his creatures, that they all ſeem loudly and unanimouſly to ſpeak to their attentive conſiderers, in the Pſalmiſt's language, *Know ye, that the Lord he is God; it is he, that hath made us, and not we our ſelves.* And as it is ſaid, *That the ſtars in their courſes fought againſt Siſera*, ſo it may be truly ſaid, that not only the ſtars, but all the reſt of the creatures do in their courſes fight againſt the atheiſt, by ſupplying an unprejudiced conſiderer of them with weapons fit to overthrow his impious error. To which purpoſe, I remember, *Ariſtotle*, in his book *de Mundo*, makes uſe of a pretty ſimile, to declare the conſpicuouſneſs of the Creator in his creatures: *Fama eſt* (ſays he) *Phidiam illum ſtatuarium, quum Minervam illam quæ eſt in arce coagmentaret, in medio ejus ſcuto faciem ſuam expreſſiſſe, oculoſque fallenti artificio ita devinxiſſe ſimulachro, eximere ut indè ipſam ſiquis cuperet, minimè poſſet, aliter quidem certè, quam ut ipſum ſolveret ſimulachrum, opuſque ejuſmodi compactile confunderet: hanc eandem rationem Deus habet in mundo, utpote qui univerſorum coagmentationem cohærentem cohibeat & coarctet, incolumitatemque univerſitatis conſervet; niſi quatenus non medio ille loco in terra ſcilicet, ubi turbida regio eſt, ſed in excelſo ſitus eſt, purus ipſe in puro loco:* 'It is reported, that when *Phidias*, the excellent ſtatuary, made the image of *Minerva*, which is in the caſtle at *Athens*, he contrived his own picture in the middle of her ſhield, and faſtened the eyes of it to the ſtatue by ſo cunning workmanſhip, that if any one were minded to take it away, he could not do it without breaking the ſtatue, and diſordering the connection of the work. After the ſame manner is God in the world, retaining and upholding the coherence of all things, and preſerving the ſafety of the univerſe: only he is not in the midſt of it, namely the earth, which is a turbulent region; but in the higheſt place, which is ſuitable to his purity.'

That thoſe people, who worſhip not God, are not naturaliſts, but barbarians; and that their atheiſm doth continue for want of the contemplation of the world.

*Pſalm* c. 3.
*Judg.* v. 20.

cap. 6.

A compariſon of the image of God on the creature to that of *Phidias* on *Minerva*'s ſhield.

BUT to declare, how athieſts may be reduced either to confeſs a firſt cauſe, or to offer violence to their own faculties, by denying things as certain as thoſe, which it is apparent that (in other caſes) themſelves firmly aſſent to, would require a diſcourſe too large to be proper to be proſecuted here; and therefore if I have not, in another treatiſe, an opportunity of inſiſting on that ſubject, I muſt content my ſelf to refer you, for further ſatisfaction on it, to the writers of natural theology.

NOR does phyſiology barely conduce to make men believe the exiſtence of a Deity, but admire and celebrate the perfections of it: and the nobleſt worſhip from that greater part of the world, to which God did not vouchſafe any explicite and particular revelation of his will, hath been paid him by thoſe, whom the beauty of this goodly temple of the univerſe tranſported with a rational wonder at the wiſdom, power, and goodneſs of the divine architect. And this kind of devotion being commonly proportionate to the diſcoveries of nature, that begot it, it needs not ſeem ſtrange, that divers of the beſt philoſophers amongſt the Heathens ſhould be the greateſt celebrators of God. And it was therefore, perhaps, not without cauſe, that the Indian gymnoſophiſts, the Perſian magi, the Egyptian ſacrificers, and the old Gauls druids, were to their people both philoſophers and prieſts; and that in divers civilized nations, philoſophy and prieſthood were ſo allied, that thoſe whoſe profeſſion ſhould give them moſt intereſt in the definition of man, made a more ſtrict profeſſion of celebrating and praiſing God. I might eaſily, with divers inſtances, manifeſt, how great a veneration the ſtudy of the creatures has given philoſophers, for thoſe attributes of God, that are ſtampt upon them, and conſpicuous in them: but my willingneſs to haſten to the more experimental part of what I have to ſay concerning the uſefulneſs of phyſiology, makes me content my ſelf to preſent you with a couple, or a leaſh of authorities, for proof of what has been alledged: the firſt ſhall be of *Galen*, in his third book *De uſu partium*, where treating of the ſkin, that inveſts the ſoal of the foot, *Cutem ipſam* (ſays he) *non laxam, aut ſubtilem, aut mollem, ſed conſtrictam, & mediocritèr duram, ſenſilemque ut non facilè pateretur, ſubdidit pedi ſapientiſſimus Conditor noſter: cui commentarios hos, ceu hymnos quoſdam compono, & in eo pietatem eſſe exiſtimans, non ſi taurorum* ἑκατόμβας *ei plurimas quiſpiam ſacrificarit, & caſias aliaque ſexcenta unguenta ſuffumigarit. Sed ſi noverim ipſe primus, deinde expoſuerim aliis, quænam ſit ipſius ſapientia, quæ virtus, quæ providentia, quæ bonitas; ignorantia quorum ſumma impietas eſt, non ſi à ſacrificio abſtineas. Quod enim cultu convenienti exornavit omnia, nullique bona inviderit id perfectiſſimæ bonitatis ſpecimen eſſe ſtatuo. Inveniſſe autem quo pacto omnia adornarentur ſummæ ſapientiæ eſt, at effeciſſe omnia quæ voluit virtutis eſt invictæ.* ‘ Our moſt wiſe Creator hath placed under the foot a ‘ ſkin, not looſe, or thin, or ſoft, but cloſe, and of indifferent hardneſs and ſenſe, to ‘ the end it might not eaſily ſuffer injury. To him I compoſe theſe commentaries as ‘ certain hymns, eſteeming piety not to conſiſt in ſacrificing many hecatombs of oxen ‘ to him, or burning caſſia, and a thouſand other perfumes; but in this, firſt to know ‘ my ſelf, and then to declare to others, what his wiſdom, power, providence, and ‘ goodneſs is: the ignorance of which, not the abſtaining from ſacrifice, is the greateſt ‘ impiety. For I account it an evidence of moſt perfect goodneſs, that he hath furniſhed all things with convenient ornament, and denied his benefits to none. Now ‘ to have deviſed, how all things might be handſomely framed, is the part of ‘ higheſt wiſdom; but to have made all things, which he would, of inſuperable ‘ power.’ To which illuſtrious paſſage he annexes much more, worthy of *Galen*'s pen, and your peruſal.

The nobleſt worſhip, that has been paid God, from ſuch, who have not had particular revelation of his will, has aroſe from the ſpeculation of God's wiſdom, power, and goodneſs in the fabrick of the creatures.

The teſtimonies of *Galen*, *Hermes*, *Paracelſus*, L. *Bacon*.

To this let me add, in the ſecond place, that of *Hermes Triſmegiſtus*, almoſt at the very beginning of his firſt book, Engliſhed by Dr. *Everard*: *He that ſhall learn and ſtudy the things that are, and how they are ordered and governed, and by whom, and for what cauſe, or to what end, will acknowledge thanks to the workman, as to a good father, an excellent nurſe, and a faithful ſteward; and he that gives thanks ſhall be pious or religious, and he that is religious ſhall know both where the truth is, and what it is; and learning that, he will be yet more and more religious.* To which I cannot but add, a reſembling paſſage of that great Hermetical philoſopher (as his followers love to call him) *Paracelſus: Oppidò* (ſays he) *admirabilis, in ſuis operibus, Deus eſt; à quorum contemplatione nec interdiu, nec noctu deſiſtendum, ſed jugiter illorum indagationi vacandum eſt, hoc enim eſt ambulare in viis Dei:* ‘ God is very admirable in his works; from the con‘ templation of which we ought not to deſiſt night or day, but continually be imployed ‘ in the inquiſition of them: *for this is to walk in the ways of God.*’ All which bears witneſs to, and may, in exchange, receive authority from that remarkable paſſage of that great and ſolid philoſopher, Sir *Francis Bacon*, who ſcruples not ſomewhere to affirm, ‘ That a little or ſuperficial taſte of philoſophy, may, perchance, incline the ‘ mind of a man to atheiſm; but a full draught thereof brings the mind back again to ‘ religion. For in the entrance of philoſophy, when the ſecond cauſes, which are next ‘ unto the ſenſes, do offer themſelves to the mind of man, and the mind itſelf cleaves ‘ unto them, and dwells there, a forgetfulneſs of the higheſt cauſe may creep in: but ‘ when a man paſſeth further, and beholds the dependency, continuation, and confede-

*Paracel.* de Mineral. Tract. I.

Sir *Francis Bacon* Advancem. of Learning, lib. I.

‘ racy of cauſes, and the works of providence, then, according to the allegory of the poets, he will eaſily believe, that the higheſt link of nature's chain muſt needs be tied to the foot of *Jupiter*'s chair :’ or (to ſpeak our chancellor's thoughts more ſcripturally) ‘ That phyſiology, like *Jacob*'s viſion, diſcovers to us a *ladder, whoſe top reaches up to the foot-ſtool of the throne of God.*’ To which he deſervedly adds; *Let no man, upon a weak conceit of ſobriety, or ill-applied moderation, think or maintain, that a man can ſearch too far, or be too well ſtudied, in the book of God's word, or in the book of God's works, divinity, or philoſophy. But rather let men awake themſelves, and cheerfully endeavour and purſue an endleſs progreſs or proficiency in both; only let them beware leſt they apply knowledge to ſwelling, not to charity, to oſtentation, not to uſe: And again, that they do not unwiſely mingle and confound theſe diſtinct learnings of theology and philoſophy, and their ſeveral waters together.*

*Gen.* xxviii.

IN the fifth place, *Pyrophilus*, I conſider, that when the divines we are anſwering, ſuppoſe phyſiology likely to render a man an atheiſt, they do it (as hath above been noted already) upon this ground, that natural philoſophy may enable him to explicate both the regular phænomena, and the aberrations of nature, without having recourſe to a firſt cauſe or God. But though this ſuppoſal were as great a truth, as we have endeavoured to make it a miſtake, yet I ſee not, why a ſtudier of phyſiology, though ever ſo great a proficient in it, may not rationally be an utter enemy to atheiſm. For the contemplation of the creatures is but one of the ways of coming to be convinced, that there is a God; and therefore, though religion were unable to make uſe of the argument drawn from the works of nature, to prove the exiſtence of a Deity, yet has ſhe other arguments enough beſides, to keep any conſiderate and impartial man from growing an atheiſt. And here give me leave, for the ſake of theſe divines, to obſerve that though the devils be ſpirits, not only extremely knowing in the properties of things, (by their hidden ſkill in phyſiology, by which they teach magicians, and their other clients, to do divers of the ſtrange things for which they are admired) but alſo unmeaſurably proud, and willing to pervert their knowledge to the cheriſhing of atheiſm, yet St. *James* informs us, *that they themſelves believe there is a God, and tremble at him:* which argues, either, that ſkill in natural philoſophy does not neceſſarily lead to atheiſm, or that there are other arguments, beſides thoſe drawn from ſcience, ſufficient to convince the moſt refractory of the exiſtence of a Deity.

That religion has other arguments beſides thoſe drawn from the works of nature, enough to keep any conſidering man from atheiſm.

*Jam.* ii. 19.

BUT not to inſiſt on any thing of this nature, nor ſo much as to mention, what proofs the conſideration of our own minds, and their in-bred notions may afford us of a Deity, I ſhall content myſelf to mind you, that the ſeveral patefactions, which God has been pleaſed to make of himſelf, to man eſpecially, thoſe made by ſeaſonably accompliſhed prophecies, and by miracles, do not only demonſtrate the being, but the providence, and divers of the attributes of God. And indeed, methinks, the divines we reaſon with, may well allow theſe patefactions to be capable of evincing the exiſtence of a God, ſince they are ſufficient, and, for aught I know, the beſt arguments we have to convince a rational man of the truth of the Chriſtian religion. For the miracles of Chriſt (eſpecially his reſurrection) and thoſe of his diſciples, by being works altogether ſupernatural, overthrow atheiſm; and being owned to be done in God's name, and to authorize a doctrine aſcribed to his inſpiration, his goodneſs and his wiſdom, permit us not to believe, that he would ſuffer ſuch numerous, great, and uncontrolled miracles, to be ſet as his ſeals to a lye, and delude men little leſs than inevitably into the belief of a doctrine not true. And as for the miracles themſelves (eſpecially that of Chriſt's reſurrection, ſo much, and ſo deſervedly inſiſted on by *Peter* to the Jews, and *Paul* to the Gentiles) the truth of them is ſo aſcertained to us by many of the ſolemneſt, and moſt authentick ways of atteſtation, whereby the certainty of matters of fact is capable of being ſatisfactorily made out, that it is hard to ſhew how theſe teſtimonies can be denied, without denying ſome acknowledged principle of reaſon, or ſome other received notion, which theſe contradictors opinions or practice manifeſt them to look upon as a truth. And upon this account, ſo much might be ſaid to evince the reaſonableneſs of aſſenting to the Chriſtian religion, and to ſhew, that as much may be ſaid for it, as need be ſaid for any religion, and much more, than can be ſaid for any other; that it need be no wonder, that, as learned men as ever the world admired, have not only been many of them embracers, but ſome of them champions of it. But having more fully, in another treatiſe, diſcourſed of this ſubject, I ſhall content my ſelf to make this inference from what has been alledged, that ſince the moſt judicious propugners of Chriſtianity have held and found, that, upon the ſcore of God's miraculous revelations of himſelf, rational men might be brought to believe the abſtruſer articles of the Chriſtian religion, thoſe revelations cannot but be ſufficient to convince them of ſo fundamental and refulgent a truth (which all the others ſuppoſe) as that of the exiſtence of God.

IN the ſixth and laſt place, I will here add (on this occaſion) that an inſight into phyſiological principles may very much aſſiſt a man to anſwer the objections of atheiſts againſt the being of a Deity, and the exceptions they make to the arguments brought to prove, that there is one. For though it has long been the cuſtom of ſuch men, to talk, as if themſelves, and thoſe of their mind, were not alone the beſt, but almoſt the only naturaliſts; and to perplex others with pretending, that, whereas it is not conceiveable, how there can be a God; all things are by the principles of the atomical philoſophy, made clear and facil: Though this, I ſay, have long been uſed among the oppoſers of a Deity, yet he, that, not regarding their confidence, ſhall attentively conſider the very firſt principles of things, may plainly enough diſcern, that of the arguments, wherewith natural philoſophy has furniſhed atheiſts, thoſe, that are indeed conſiderable, are far fewer than one would readily think; and that the difficulty of conceiving the eternity, ſelf-exiſtence, and ſome other attributes of God (though that afford them their grand objection) proceeds not ſo much from any abſurdity belonging to the notion of a Deity, as ſuch; as from the difficulty, which our dim human intellects find to conceive the nature of thoſe firſt things (whatever we ſuppoſe them) which, to be the cauſes of all others, muſt be themſelves without cauſe: for he, that ſhall attentively conſider, what the atomiſts themſelves may be compelled to allow, concerning the eternity of matter, the origin of local motion (which plainly belongs not to the nature of body) the infinity or boundleſſneſs of ſpace, the diviſibleneſs or non-diviſibility of each corporeal ſubſtance into infinite material parts, may clearly perceive, that the atomiſt, by denying, that there is a God, cannot free his underſtanding from ſuch puzzling difficulties, as he pretends to be the reaſons of his denial: for inſtead of one God, he muſt confeſs an infinite number of atoms to be eternal, ſelf-exiſtent, immortal, ſelf-moving, and muſt make ſuppoſitions, incumbred with difficulties enough to him, that has competently accuſtomed his thoughts to leave ſecond cauſes, beneath them, and contemplate thoſe cauſes, that have none. But I am unwilling to ſwell this eſſay, by inſiſting on ſuch conſiderations as theſe, eſpecially ſince you may find them more aptly deduced in other papers, ſome of which treat of the truth of Chriſtian religion, and others are deſigned for the illuſtration of ſome things in this and the foregoing eſſays. For I muſt confeſs to you, *Pyrophilus*, that by reaſon of ſundry avocations, I have been ſo diverted from propoſing ſome of the reaſons I have employed to their beſt advantage, that I my ſelf, at another time, could have both mentioned them with leſſer diſadvantage, and have added divers others: and therefore, I have not only had thoughts of enlarging upon ſome paſſages of our paſt diſcourſe, but I long ſince made a collection (though it be not now in my power) of obſervations, and experiments to elucidate a point in one of thoſe diſcourſes, whereby may be enervated one of the three chief phyſiological reaſonings, that I have met with, among the atheiſts.

That the difficulty of conceiving the eternity, ſelf-exiſtence, and other attributes of one God, is leſs, than to conceive infinite eternal ſelf-exiſtent and ſelf-moving atoms.

Upon conſideration of all the premiſes, I confeſs, *Pyrophilus*, that I am inclined to think there may, perhaps, be more cauſe to apprehend, that the delightfulneſs of the ſtudy of phyſiology ſhould too much confine your thoughts and joys to the creatures, than that your proficiency in it ſhould bring you to diſbelieve the Creator. For I have obſerved it to be a fault, incident enough to ingenious perſons, to let their minds be ſo taken up, and, as it were, charmed with that almoſt infinite variety of pleaſing objects, which nature preſents to their contemplation, that they too much diſ-reliſh other pleaſures and employments, and are too apt to undervalue even thoſe, wherewith the improved opportunities of ſerving God, or holding communion with him, are capable of bleſſing the pious ſoul.

But, *Pyrophilus*, though comparatively to fame, and miſtreſſes, and bags, and bottles, and thoſe other tranſient, unſatisfactory, (in a word) deluding objects, on which the greateſt part of miſtaken mortals ſo fondly doat, the entertaining of our nobleſt faculties with objects ſuited to them, and proper both to gratify our curioſity, and to enrich our underſtandings, with variety of acceptable and uſeful notions, affords a ſatisfaction, that very well deſerves the choice and preference of a rational creature; yet certainly, *Pyrophilus*, as God is infinitely better than all the things, that he has made, ſo the knowledge of him is much better than the knowledge of them: and he, that has placed ſo much delightfulneſs in a knowledge, wherein he allows his very enemies to become very great proficients, has ſure reſerved much higher, and more contenting pleaſures to ſweeten and endear thoſe diſcloſures of himſelf, which he vouchſafes to none but thoſe that love him, and are loved by him.

As God is infinitely better than all his creatures, ſo the knowledge of him is better than the knowledge of his creatures.

And therefore, *Pyrophilus*, though I will allow you to expect from the contemplation of nature a greater ſatisfaction, than from any thing you need decline for it, yet I would not have you expect from it any ſuch ſatisfaction as you may entirely acquieſce in; for nothing but the enjoyment of him, that made the ſoul for himſelf, can ſatisfy it, the creatures being as well uncapable to afford us a complete felicity by our intellectual ſpeculations of them, as by our ſenſual fruitions of them. For though the knowledge of nature be preferable by odds to thoſe other idols, which we have mentioned, as inferiour to it, yet we here attain that knowledge but very imperfectly, and our acquiſitions of it coſt us ſo dear, and the pleaſure of them is ſo allayed with the diſquieting curioſity they are wont to excite, that the wiſeſt of men, and greateſt of philoſophers among the ancients, ſcruples not, upon his own experience, to call the addicting of *one's heart to ſeek and ſearch out by wiſdom, concerning all things that are done under the heaven, a ſore travel given by God to the ſons of men*; *to be exerciſed* (or, as the original hath it, *to afflict themſelves) therewith.* And the ſame experienced writer elſewhere tells us, *That he that increaſes knowledge, increaſes ſorrow.* And it was perhaps for this reaſon, that *Adam* was formed out of paradiſe, and afterwards by God brought into it, to intimate, that felicity is not a thing, that man can acquire for himſelf, but muſt receive as a free gift from the liberal hand of God. And as the children of the prophets ſought tranſlated *Elias* with very great diligence, but with no ſucceſs, ſo do we, as fruitleſly as induſtriouſly, ſeek after perfect happineſs here, both they and we miſſing of what we ſeek, for the ſame reaſon; becauſe we ſeek for that on earth, which is not to be found but in heaven. And this I forewarn you of, *Pyrophilus*, not at all to diſcourage you from the ſtudy of phyſiology, but to keep you from meeting with that great diſcouragement of finding in it much leſs of ſatisfaction than you expected; an over-great expectation from it being one of the diſadvantagiouſeſt circumſtances with which it is poſſible for any thing to be enjoyed.

The imperfection and diſquiet, that there is in human ſcience. *Eccleſ.* i. 13.

*Eccleſ.* i. 18.

2 *Kings* cap. ii.

But at length, *Pyrophilus*, though late, I begin to diſcern, into how tedious a digreſſion my zeal for natural philoſophy, and for you, has miſ-led me, and how it has drawn from my pen ſome paſſages, which may ſeem to reliſh more of the preacher, than the naturaliſt; yet I might alledge divers things to juſtify, or, at leaſt, extenuate what I have done: as firſt, that if in making this excurſion I have erred, I have not done ſo without the authority of great examples. For not only *Seneca* doth frequently both ſeaſon his natural ſpeculations with moral documents and reflexions, and owns, that he purpoſely does ſo, where he ſays, *Omnibus rebus, omnibuſque ſermonibus aliquid ſalutare miſcendum eſt, cum imus per occulta naturæ, &c.* But even *Pliny* (as far as he was from being guilty of over-much devotion) does, from divers paſſages in his Natural Hiſtory, allow himſelf to take occaſion to inveigh againſt the luxury, exceſſes, and other epidemical vices of his time. And I might next repreſent, that perhaps the endeavouring to manifeſt, that the knowledge of the creatures ſhould, and how it may be referred to the Creator's glory, is not altogether impertinent to the deſign I have of promoting phyſiology; for it ſeems conſonant both to God's goodneſs, and that repeated axiom in the goſpel, which tells us, *that he, that improves his talents to good uſes, ſhall be intruſted with more*; that the imploying the little knowledge I have in the ſervice of him I owe it to, may invite him to increaſe that little, and make it leſs deſpicable. And perhaps it is not the leaſt cauſe of our ignorance, in natural philoſophy itſelf, that when we ſtudy the great book of nature, called the Univerſe, we conſult, peradventure, almoſt all other expoſitors to underſtand its myſteries, without making any addreſs for inſtruction to the author, who yet is juſtly ſtyled in the Scripture, *that Father of lights* (in the plural number) *from whom deſcends every good and every perfect gift*; not only thoſe ſupernatural graces, that relate to another world, but thoſe intellectual endowments, that qualify men for the proſperous contemplation of this: and therefore in the evangelical prophet, he is ſaid to inſtruct even the plough-man, and teach him the ſkill and underſtanding he diſplays in his own profeſſion. And though I dare not affirm, with ſome of the Helmontians and Paracelſians, that God diſcloſes to men the great myſtery of chymiſtry by good angels, or by nocturnal viſions, as he once taught *Jacob*, to make lambs and kids come into the world ſpeckled, and ring-ſtreaked; yet perſuaded I am, that the favour of God does (much more than moſt men are aware of) vouchſafe to promote ſome men's proficiency in the ſtudy of nature, partly by protecting their attempts from thoſe unlucky accidents, which often make ingenuous and induſtrious endeavours miſcarry; and partly by making them dear and acceptable to the poſſeſſors of ſecrets, by whoſe friendly communication they may often learn that in a few moments, which coſt the imparters many a year's toil and ſtudy; and partly too, or rather principally, by directing them to thoſe happy and pregnant hints, which an ordinary ſkill and induſtry may ſo improve, as to do ſuch things, and make ſuch diſcoveries by virtue of them, as both others, and the perſon himſelf, whoſe knowledge is thus increaſed, would ſcarce have imagined to be poſſible: and in effect, the chiefeſt of the ſecrets, that have been communicated to me, the owners have acknowledged to me to have been attained, rather, as they were pleaſed to ſpeak, by accidental hints, than accurate inquiries: conceſſions of this nature I have divers times met with in the writings of the more ingenious of the chymiſts, and of other naturaliſts, and by one of theſe accidental hints, of late, the acute and lucky *Pecquet* was directed to find the newly diſcovered *lactea thoracica*, as before him *Aſellius* found without ſeeking, as himſelf confeſſeth, the *lactea meſenterica*; and by an accident too (as himſelf hath told me) did our induſtrious anatomiſt, Dr. *Jolive*, firſt light upon thoſe yet more freſhly detected veſſels, which afterwards the ingenious *Bartholinus*, without being informed of them, or ſeeking for them, hath met with, and acquainted the world with, under the name of *vaſa lymphatica*; and the two great inventions of the latter ages, gunpowder, and the loadſtone's reſpect unto the poles, are ſuppoſed to be due rather to chance, than any extraordinary ſkill in philoſophical principles (which indeed would ſcarce have made any man dream of ſuch extravagant properties, as thoſe of magnetick bodies) as if God

*Seneca* Nat. quæſt. lib. 2. cap. 59.

How the favour of God conduces to promote men's proficiency in the ſtudy of nature.

*Jam.* i. 17.

*Iſa.* xxviii. 25, 26.

*Gen.* xxxi.

UPON conſideration of all the premiſes, I confeſs, *Pyrophilus*, that I am inclined to think there may, perhaps, be more cauſe to apprehend, that the delightfulneſs of the ſtudy of phyſiology ſhould too much confine your thoughts and joys to the creatures, than that your proficiency in it ſhould bring you to diſbelieve the Creator. For I have obſerved it to be a fault, incident enough to ingenious perſons, to let their minds be ſo taken up, and, as it were, charmed with that almoſt infinite variety of pleaſing objects, which nature preſents to their contemplation, that they too much diſ-reliſh other pleaſures and employments, and are too apt to undervalue even thoſe, wherewith the improved opportunities of ſerving God, or holding communion with him, are capable of bleſſing the pious ſoul.

As God is infinitely better than all his creatures, ſo the knowledge of him is better than the knowledge of his creatures.

BUT, *Pyrophilus*, though comparatively to fame, and miſtreſſes, and bags, and bottles, and thoſe other tranſient, unſatisfactory, (in a word) deluding objects, on which the greateſt part of miſtaken mortals ſo fondly doat, the entertaining of our nobleſt faculties with objects ſuited to them, and proper both to gratify our curioſity, and to enrich our underſtandings, with variety of acceptable and uſeful notions, affords a ſatiſfaction, that very well deſerves the choice and preference of a rational creature; yet certainly, *Pyrophilus*, as God is infinitely better than all the things, that he has made, ſo the knowledge of him is much better than the knowledge of them: and he, that has placed ſo much delightfulneſs in a knowledge, wherein he allows his very enemies to become very great proficients, has ſure reſerved much higher, and more contenting pleaſures to ſweeten and endear thoſe diſcloſures of himſelf, which he vouchſafes to none but thoſe that love him, and are loved by him.

The imperfection and diſquiet, that there is in human ſcience. *Eccleſ.* i. 13.

*Eccleſ.* i. 18.

2 *Kings* cap. ii.

AND therefore, *Pyrophilus*, though I will allow you to expect from the contemplation of nature a greater ſatisfaction, than from any thing you need decline for it, yet I would not have you expect from it any ſuch ſatisfaction as you may entirely acquieſce in; for nothing but the enjoyment of him, that made the ſoul for himſelf, can ſatisfy it, the creatures being as well uncapable to afford us a complete felicity by our intellectual ſpeculations of them, as by our ſenſual fruitions of them. For though the knowledge of nature be preferable by odds to thoſe other idols, which we have mentioned, as inferiour to it, yet we here attain that knowledge but very imperfectly, and our acquiſitions of it coſt us ſo dear, and the pleaſure of them is ſo allayed with the diſquieting curioſity they are wont to excite, that the wiſeſt of men, and greateſt of philoſophers among the ancients, ſcruples not, upon his own experience, to call the addicting of *one's heart to ſeek and ſearch out by wiſdom, concerning all things that are done under the heaven, a ſore travel given by God to the ſons of men; to be exerciſed* (or, as the original hath it, *to afflict themſelves) therewith.* And the ſame experienced writer elſewhere tells us, *That he that increaſes knowledge, increaſes ſorrow.* And it was perhaps for this reaſon, that *Adam* was formed out of paradiſe, and afterwards by God brought into it, to intimate, that felicity is not a thing, that man can acquire for himſelf, but muſt receive as a free gift from the liberal hand of God. And as the children of the prophets ſought tranſlated *Elias* with very great diligence, but with no ſucceſs, ſo do we, as fruitleſly as induſtriouſly, ſeek after perfect happineſs here, both they and we miſſing of what we ſeek, for the ſame reaſon; becauſe we ſeek for that on earth, which is not to be found but in heaven. And this I forewarn you of, *Pyrophilus*, not at all to diſcourage you from the ſtudy of phyſiology, but to keep you from meeting with that great diſcouragement of finding in it much leſs of ſatisfaction than you expected; an over-great expectation from it being one of the diſadvantagiouſeſt circumſtances with which it is poſſible for any thing to be enjoyed.

BUT at length, *Pyrophilus*, though late, I begin to diſcern, into how tedious a digreſſion my zeal for natural philoſophy, and for you, has miſ-led me, and how it has drawn from my pen ſome paſſages, which may ſeem to reliſh more of the preacher, than the naturaliſt; yet I might alledge divers things to juſtify, or, at leaſt, extenuate what I have done: as firſt, that if in making this excurſion I have erred, I have not done ſo without the authority of great examples. For not only *Seneca* doth frequently both ſeaſon his natural ſpeculations with moral documents and reflexions, and owns, that he purpoſely does ſo, where he ſays, *Omnibus rebus, omnibuſque ſermonibus aliquid ſalutare miſcendum eſt, cum imus per occulta naturæ, &c.* But even *Pliny* (as far as he was from being guilty of over-much devotion) does, from divers paſſages in his Natural Hiſtory, allow himſelf to take occaſion to inveigh againſt the luxury, exceſſes, and other epidemical vices of his time. And I might next repreſent, that perhaps the endeavouring to manifeſt, that the knowledge of the creatures ſhould, and how it may be referred to the Creator's glory, is not altogether impertinent to the deſign I have of promoting phyſiology; for it ſeems conſonant both to God's goodneſs, and that repeated axiom in the goſpel, which tells us, *that he, that improves his talents to good uſes, ſhall be intruſted with more*; that the imploying the little knowledge I have in the ſervice of him I owe it to, may invite him to increaſe that little, and make it leſs deſpicable. And perhaps it is not the leaſt cauſe of our ignorance, in natural philoſophy itſelf, that when we ſtudy the great book of nature, called the Univerſe, we conſult, peradventure, almoſt all other expoſitors to underſtand its myſteries, without making any addreſs for inſtruction to the author, who yet is juſtly ſtyled in the Scripture, *that Father of lights* (in the plural number) *from whom deſcends every good and every perfect gift*; not only thoſe ſupernatural graces, that relate to another world, but thoſe intellectual endowments, that qualify men for the proſperous contemplation of this: and therefore in the evangelical prophet, he is ſaid to inſtruct even the plough-man, and teach him the ſkill and underſtanding he diſplays in his own profeſſion. And though I dare not affirm, with ſome of the Helmontians and Paracelſians, that God diſcloſes to men the great myſtery of chymiſtry by good angels, or by nocturnal viſions, as he once taught *Jacob*, to make lambs and kids come into the world ſpeckled, and ring-ſtreaked; yet perſuaded I am, that the favour of God does (much more than moſt men are aware of) vouchſafe to promote ſome men's proficiency in the ſtudy of nature, partly by protecting their attempts from thoſe unlucky accidents, which often make ingenuous and induſtrious endeavours miſcarry; and partly by making them dear and acceptable to the poſſeſſors of ſecrets, by whoſe friendly communication they may often learn that in a few moments, which coſt the imparters many a year's toil and ſtudy; and partly too, or rather principally, by directing them to thoſe happy and pregnant hints, which an ordinary ſkill and induſtry may ſo improve, as to do ſuch things, and make ſuch diſcoveries by virtue of them, as both others, and the perſon himſelf, whoſe knowledge is thus increaſed, would ſcarce have imagined to be poſſible: and in effect, the chiefeſt of the ſecrets, that have been communicated to me, the owners have acknowledged to me to have been attained, rather, as they were pleaſed to ſpeak, by accidental hints, than accurate inquiries: conceſſions of this nature I have divers times met with in the writings of the more ingenious of the chymiſts, and of other naturaliſts, and by one of theſe accidental hints, of late, the acute and lucky *Pecquet* was directed to find the newly diſcovered *lactea thoracica*, as before him *Aſellius* found without ſeeking, as himſelf confeſſeth, the *lactea meſenterica*; and by an accident too (as himſelf hath told me) did our induſtrious anatomiſt, Dr. *Jolive*, firſt light upon thoſe yet more freſhly detected veſſels, which afterwards the ingenious *Bartholinus*, without being informed of them, or ſeeking for them, hath met with, and acquainted the world with, under the name of *vaſa lymphatica*; and the two great inventions of the latter ages, gunpowder, and the loadſtone's reſpect unto the poles, are ſuppoſed to be due rather to chance, than any extraordinary ſkill in philoſophical principles (which indeed would ſcarce have made any man dream of ſuch extravagant properties, as thoſe of magnetick bodies) as if God

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deſigned to keep philoſophers humble, and (though he allow regular induſtry ſufficient encouragement, yet) to remain himſelf diſpenſer of the chief myſteries of nature.

The reaſon of the author's ſo long diſcourſe on this ſubject.

To what hath been repreſented, *Pyrophilus*, I might add much more to excuſe my excurſions, if I were not content to be beholden to you for a pardon; and to invite you to grant it me, I ſhall promiſe you to be very careful not to repeat the like offence. And whereas moſt chymical writers take occaſion, from almoſt every diſcovery or proceſs they acquaint us with, to digreſs and wander into tedious, and too often dull and impertinent theological reflections or ſermons; I have troubled you with almoſt all that I have to ſay (to you) of theological at once, and I have endeavoured to ſprinkle it, as far as the ſubject would allow me, with ſome paſſages experimental. And indeed I ſhould not at all have engaged my ſelf into ſo long a diſcourſe of the not only innocency, but uſefulneſſes of the knowledge of nature, in reference to religion, but that I could not acquieſce in what I had met with on that ſubject in any of the writers I have peruſed, divines being commonly too unacquainted with nature, to be able to manage it phyſiologically enough, and naturaliſts commonly eſteeming it no part of their work to treat of it at all. And therefore I ſcruple not to confeſs freely to you, *Pyrophilus*, that, as I ſhall think my ſelf richly rewarded for all the enſuing eſſays, if the paſt diſcourſe but prove ſo happy as to bring you to value, and to make the religious uſe of the creatures recommended to you in it; ſo I had rather any of my papers ſhould be paſſed by unperuſed, than thoſe parts of theſe eſſays, that treat of that uſe. And indeed it is none of the leaſt of ſatisfactions I hope to derive from my phyſical compoſures, that by premiſing before them the now almoſt finiſhed diſcourſe, I have done my hearty endeavour to manifeſt and recommend the true uſe of all the diſcoveries of nature, which either my inquiries, or your own, may afford you. And indeed for my part, *Pyrophilus*, I eſteem the doctrine I have been pleading for of that importance, that I am perſuaded, that he, that could bring philoſophical devotion into the requeſt it merits, would contribute as much to the ſolemnizing of God's praiſes, as the benefactors of choriſters and founders of chauntries, and not much leſs than *David*'s ſo celebrated deſignation and ſettlement of that religious Levitical muſick, inſtituted for the ſolemn celebration of God.

Beaſts inhabit and enjoy the world, it is man's duty to ſpiritualize it.

That it being the prime duty of man to give God the honour of his creatures, it is to be preferred before ſecondary duties.

For the ſenſible repreſentations of God's attributes to be met with in the creatures, occurring almoſt every where to our obſervation, would very aſſiduouſly ſollicit us to admire him, did we but arightly diſcern him in them; and the impreſſions made on the mind by theſe repreſentations, proceeding not from a bare (and perhaps languid) whether belief or notion of the perfections expreſſed in them, but from an actual and operative intuition of them, would excite an admiration (with the devotion ſpringing thence) by ſo much the more intenſe, by how much (it would be) more rational. And ſure, *Pyrophilus*, ſo much admirable workmanſhip, as God hath diſplayed in the univerſe, was never meant for eyes that wilfully cloſe themſelves, and affront it with the not judging it worthy the ſpeculating. Beaſts inhabit and enjoy the world; man, if he will do more, muſt ſtudy, and (if I may ſo ſpeak) ſpiritualize it. It is the firſt act of religion, and equally obliging in all religions: it is the duty of man, as man; and the homage we pay for the privilege of reaſon; which was given us, not only to refer our ſelves, but the other creatures, that want it, to the Creator's glory. Which makes me ſometimes angry with them, who ſo buſy themſelves in the duties and imployments of their ſecond and ſuperinduced relations, that they will never find the leiſure to diſcharge that primitive and natural obligation, who are more concerned as citizens of any place, than of the world; and both worſhip God ſo barely as Catholick or Proteſtants, Anabaptiſts or Socinians, and live ſo wholly as lords or counſellors, Londoners or Pariſians, that they will never find the leiſure, or conſider not, that it concerns them to worſhip and live as men.

And the neglect of this philoſophical worſhip of God, for which we are pleading, ſeems to be culpable in men proportionably to their being qualiſied, and comply with that invitation of the Pſalmiſt, *to ſing praiſes to God with underſtanding*, or (the expreſſion in the original being ſomewhat ambiguous) *to ſing to him a learned canticle*, as he elſewhere ſpeaks, *to praiſe him according to his excellent greatneſs.* For knowledge being a gift of God, intruſted to us to glorify the giver with it, the greatneſs of it muſt aggravate the neglect of imploying it gratefully; and the ſublimeſt knowledge here attainable will not deſtroy, but only heighten and ennoble our admiration, and will prove the incenſe or more ſpiritual and acceptable part of that ſacrifice of praiſe, (for thoſe reflections, which their nature makes only acts of reaſon, their end may make acts of piety) wherein the intelligent admirer offers the whole world in euchariſts to its Maker. For admiration (I do not ſay aſtoniſhment or ſurprize) being an acknowledgment of the objects tranſcending our knowledge, the learneder the tranſcendent faculty is, the greater is the admired objects tranſcendency acknowledged. And certainly, God's wiſdom is much leſs glorified by the vulgar aſtoniſhment of an unlettered ſtarer, (whoſe ignorance may be as well ſuſpected for his wonder, as the excellency of the object) than from their learned hymns, whoſe induſtrious curioſity hath brought their underſtandings to a proſtrate veneration of what their reaſon, not ignorance, hath taught them not to be perfectly comprehenſible by them.

*Pſal.* xlvii. 7.
*Pſal.* cl. 2.

And as ſuch perſons have ſuch piercing eyes, that where a tranſient or unlearned glance ſcarce obſerves any thing, they can diſcern an adorable wiſdom, being able (as I may ſo ſpeak) to read the ſtenography of God's omniſcient hand; ſo their ſkilful fingers know how to chuſe and how to touch thoſe ſtrings, that may ſound ſweeteſt to the praiſe of their Maker. And on the opened body of the ſame animal, a ſkilful anatomiſt will make reflections, as much more to the honour of its Creator, than an ordinary butcher can; as the muſick made on a lute, by a rare lutaniſt, will be preferable to the noiſe made on the ſame inſtrument by a ſtranger unto melody. And give me leave to tell you, *Pyrophilus*, that ſuch a reaſonable worſhip (λογικὴ λατρεία) of God (to uſe St. *Paul*'s expreſſion, though in another ſenſe) is perhaps a much nobler way of adoring him, than thoſe, that are not qualified to practiſe it, are aware of, and is not improper even for Chriſtians to exerciſe. For, *Pyrophilus*, it would be conſidered, that as God hath not, by becoming (as the Scripture more than once ſtyles him) our Saviour, laid by his firſt relation to us as our Creator (whence St. *Peter* exhorts, even the ſuffering Chriſtians of his time, to commit their ſouls to God under the notion of a faithful Creator) ſo neither hath he given up his right to thoſe intelligent adorations from us, which become us upon the account of being his rational creatures: neither are ſuch performances made leſs acceptable to him by the filial relation, into which Chriſt hath brought us to him; that glorious relation as well endearing to him our ſervices, as our perſons.

That the different greatneſs in the knowledge makes a like difference in the honour given to the Creator.
*Rom.* xii. 1.
1 *Tim.* i. 1.
*Tit.* ii. 10.
1 *Pet.* iv. 19.
God, by becoming our Saviour, has not laid aſide the relation of a Creator.

And let me add, *Pyrophilus*, that not only *Galen* (as we have ſeen already) tells us, that the diſcerning one's ſelf, and diſcovering to others the perfections of God diſplayed in the creatures, is a more acceptable act of religion, than the burning of ſacrifices or perfumes upon his altars: and not only *Triſmegiſtus*, forbidding *Aſclepius* to burn incenſe, tells him, 'That the thanks and praiſes of men, are the nobleſt incenſe that 'can be offered up to God:' But God himſelf (in his written word) is pleaſed to ſay, *That he, that ſacrificeth praiſe* (for ſo it is in the original) *honoureth him.* And the Scripture conſonantly mentions as a very acceptable part of religious worſhip, the *ſacrifice of praiſe, and the calves of our lips:* by offering up of which, we make that true uſe of the creatures, of ſo referring them to their Creator's glory, that (to conclude this diſcourſe by crowning it, as it were, with that excellent circle mentioned by the Apoſtle) as *all things are of him, and through him*, ſo they may be *to him*; *to whom be glory for ever*, Amen.

That he, who ſacrificeth praiſe, honoureth God.
*Hermes Triſm.* in *Aſclep.* c. 15.
The concluſion.
*Heb.* xiii. 15.
*Rom.* xi. 36.

# OF THE USEFULNESS OF NATURAL PHILOSOPHY.

## PART II.

## SECT. I.

## Of its Uſefulneſs to PHYSICK.

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### ESSAY I.

### *Containing ſome particulars tending to ſhew the Uſefulneſs of* NATURAL PHILOSOPHY *to the Phyſiological Part of Phyſick.*

The advantage of the knowledge of nature towards the increaſing the power of man; and its uſe as to health of the body and goods of fortune.

AFTER having, in the former part of this treatiſe, *Pyrophilus*, thus largely endeavoured to manifeſt to you the advantageouſneſs of natural philoſophy to the mind of man, we ſhall now proceed to ſpeak of its uſefulneſs both to his body and fortune. For I muſt ingenuouſly confeſs to you, *Pyrophilus*, that I ſhould not have near ſo high a value as I now cheriſh for phyſiology, if I thought it could only teach a man to diſcourſe of nature, but not at all to maſter her; and ſerved only, with pleaſing ſpeculations to entertain his underſtanding, without at all increaſing his power. And though I preſume not to judge of other men's knowledge; yet, for my own particular, I ſhall not dare to think my ſelf a true naturaliſt, till my ſkill can make my garden yield better herbs and flowers, or my orchard better fruit, or my field better corn, or my dairy better cheeſe, than theirs that are ſtrangers to phyſiology. And certainly, *Pyrophilus*, if we ſeriouſly intend to convince the diſtruſtful world of the real uſefulneſs of natural philoſophy, we muſt take ſome ſuch courſe, as that Mileſian *Thales* did, who was by the antients reckoned among the very firſt of their naturaliſts, and their ſeven celebrated wiſe men. Of this *Thales* it is reported, that being upbraidingly demanded, what advantage the profeſſors of aſtrology could derive from the knowledge of it; he aſtrologically foreſeeing what a year it would prove for olives, before any wonted ſigns of it did appear to huſbandmen, ingroſſed, by giving earneſt, the greater part of the olives, which the next ſeaſon ſhould afford to *Chios* and *Miletus*; and being thereby enabled, when moſt men wanted oil, to ſell his at his own rates, he made advantage enough of his ſkill, to let his friends ſee, that philoſophers may have the acquiſition of wealth more in their power than in their aim.

METHINKS, it ſhould be a diſparagement to a philoſopher, when he deſcends to conſider huſbandry, not to be able, with all his ſcience, to improve the precepts of an art, reſulting from the lame and unlearned obſervations and practice of ſuch illiterate perſons as gardeners, plowmen, and milkmaids. And indeed, *Pyrophilus*, though it be but

That in man's knowledge of the nature of creatures, conſiſts his empire over them.

but too evident, that the barren philoſophy, wont to be taught in the ſchools, hath hitherto been found of very little uſe in human life; yet if the true principles of that fertile ſcience were thoroughly known, conſidered, and applied, it is ſcarce imaginable, how univerſal and advantageous a change they would make in the world. For in man's knowledge of the nature of the creatures, doth principally conſiſt his empire over them, (his knowledge and his power having generally the ſame limits.) And as the nerves, that move the whole body, and by it, that great variety of engines imployed by man on his manifold occaſions, proceed from the brain; ſo all the operations, by which we alter nature, and produce ſuch changes in the creatures, flow from our knowledge of them. Theological inquiries excepted, there is no imployment, wherein mankind is ſo much and ſo generally concerned, as it is in the ſtudy of natural philoſophy. And thoſe great tranſactions, which make ſuch a noiſe in the world, and eſtabliſh monarchies or ruin empires, reach not ſo many perſons with their influence, as do the theories of phyſiology.

That the diſcovery of *America* is owed to the knowledge of the loadſtone's polarity.

That the martial affairs all over the world were altered by the knowledge of the nature of brimſtone and ſalt-petre.

To manifeſt this truth, we need but conſider, what changes in the face of things have been made by two diſcoveries, trivial enough; the one being but of the inclination of the needle, touched by the loadſtone, to point toward the pole; the other being but a caſual diſcovery of the ſuppoſed antipathy between ſalt-petre, and brimſtone: for without the knowledge of the former, thoſe vaſt regions of *America*, and all the treaſures of gold, ſilver, and precious ſtones, and much more precious ſimples they ſend us, would have probably continued undetected; and the latter giving an occaſional riſe to the invention of gunpowder, hath quite altered the condition of martial affairs over the world, both by ſea and land. And certainly, true natural philoſophy is ſo far from being a barren ſpeculative knowledge, that phyſick, huſbandry, and very many trades (as thoſe of tanners, dyers, brewers, founders, *&c.*) are but corollaries or applications of ſome few theorems of it.

How prejudicial the miſtake of that aphoriſm (that if teeming women be let blood, they will miſcarry) hath been to female patients.

If I had not a great reſpect for the great *Hippocrates*, I ſhould venture to ſay, that ſome of thoſe rigid laws of *Draco* (whoſe ſeverity made men ſay, that they were written in blood) have, perhaps, coſt fewer perſons their lives, than that one aphoriſm of *Hippocrates* *, which teaching, 'That if a teeming woman be let blood, ſhe will miſcarry,' has for divers ages prevailed with great numbers of phyſicians, to ſuffer multitudes of their female patients to die under their hands, who might probably have been reſcued by a diſcreet phlebotomy, which experience hath aſſured us (whatever the cloſe of the aphoriſm ſays to the contrary) to have been ſometimes not only ſafely, but uſefully employed, even when the infant is grown pretty big. But my reſpect for ſo great a perſon as *Hippocrates* makes me content it ſhould be thought, that, till of late, phyſicians have for the moſt part miſtaken their dictator's meaning in this aphoriſm, provided it be granted me, that through this miſtake numbers of teeming women have been ſuffered to periſh, who might probably, by the ſeaſonable loſs of ſome of their blood, have prevented that of their lives.

Comment. in Aph. I. Lib. I.

And if an error, which occaſioned only a fault of omiſſion, hath been ſo prejudicial to mankind, I ſuppoſe you will readily grant, that thoſe errors of phyſicians, that are apt to produce faults of commiſſion, and raſh attempts, may prove much more hurtful. And ſo much I find to be acknowledged by *Galen*, in that honeſt and excellent paſſage of his, in his *Comment upon the Aphoriſms*, where having mentioned the danger of trying concluſions upon men, by reaſon of the nobleneſs of the ſubject; and having added, that the phyſicians art is not like that of a potter, a carpenter, or the like, where a man may freely try what he pleaſes to gratify his curioſity, or ſatisfy himſelf about his notions, becauſe, that if he ſpoils (for inſtance) the wood he works on, no body is endangered by his miſcarriage; he thus concludes, *In corpore autem humano ea tentare, quæ non ſunt experientium comprobata periculo, non vacat*; *cùm temerariæ experientiæ finis ſit totius animantis internecio*; ‘ But I dare not try thoſe things upon human ‘ body, which have not been before tried upon former experiences; for the end of ſuch ‘ raſh experiments may be the ruin of all lives.’

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* *Hipp.* Aph. Lib. V. Γυνὴ ἐν γαστρὶ ἔχουσα, φλεβοτομωθεῖσα ἐκτιτρώσκει· καὶ μᾶλλον εἰ μεῖζον εἴη τὸ ἔμβρυον.

The intereſt of this knowledge to the happineſs and life of man.

And indeed, ſince the phyſician borrows his principles of the naturaliſt, I cannot but ſomewhat admire to ſee divers perſons, who are by themſelves and others thought ſuch wiſe men, think the ſtudy of natural philoſophy of ſmall concernment: for when by their policy or good fortune, they have acquired never ſo much wealth or power, and all other tranſitory goods, and are bleſt with children to inherit them, if the principles of natural philoſophy be miſlaid, we oftentimes ſee the ignorance or the miſtake of a doctor, deprive them of all at once, and ſhew how dangerous it is to be ſolicitous of the means of attaining the accommodations of life, with the contempt of that knowledge, which in very many caſes is humanly neceſſary to the preſervation of life itſelf.

But, *Pyrophilus*, though our unintended prolixity in the former part of our diſcourſe, concerning the uſefulneſs of phyſiology, oblige us to the greater brevity in this latter part of it; yet, to ſhew you, that of the two things, which you may remember we told you, *Pythagoras* pronounced moſt god-like in man, (*The knowledge of truth, and the doing of good*) phyſiology as well qualifies us for the latter, as it inriches us with the former. It will not be amiſs a little more particularly (though as ſuccinctly as ſo copious a ſubject will permit) to conſider the probability there is, that no ſmall improvement may be made by men's proficiency in experimental knowledge of thoſe arts, which are the chiefeſt inſtruments of man's dominion over the creatures. Theſe arts (to divide them not accurately, but popularly) do ſerve either to relieve man's neceſſities, as phyſick and huſbandry; or for his accommodation, as the trades of ſhoe-makers, dyers, tanners, *&c.* or for his delight, as the trades of painters, confectioners, perfumers, *&c.* to all which arts, and many others allied to them, philoſophical experiments and obſervations may, by a knowing naturaliſt, be made to extend a meliorating influence.

The enumeration of thoſe arts, to which this knowledge is profitable.

The method or way intended for the enſuing diſcourſe.

If I ſhould, *Pyrophilus*, ſay this, without offering any thing at all by way of proof, that I ſay it not inconſiderately, you would, I fear, believe, that I deliver it too ſlightly for a matter of that moment: and if, on the other ſide, I ſhould in this diſcourſe, preſent to you all the particulars, that I think I could without impertinency employ, to countenance what I have ſaid, it would ſwell this treatiſe to a volume, and defraud divers of my other eſſays. And therefore I hold it not unfit to chuſe a middle way, and ſet down, on this occaſion, either only, or chiefly thoſe things, which do the moſt readily occur to me, and do not ſo properly belong to the reſt of my phyſiological papers. And to avoid confuſion, I ſhall, according to the diviſion newly propoſed, employ one ſection of this ſecond part of the preſent treatiſe, in ſetting down ſuch things, as relate to the improvement of phyſick. And in the other ſection, deliver ſuch particulars, as concern thoſe other uſeful arts, that depend upon natural philoſophy. But in regard that (as I have already intimated) the following diſcourſe is to conſiſt chiefly of thoſe things, that belong not to any of my other eſſays, you will not, I preſume, expect that I ſhould handle any ſubject fully or methodically on this occaſion: which warning I eſpecially intend for that part of the enſuing diſcourſe, that relates to phyſick. For you will eaſily believe, that I am far from pretending to be a doctor in that faculty: and accordingly, in this and the four following eſſays, I ſhall only throw together divers ſuch particulars, as, not belonging to my writing, would perhaps be loſt, if I did not lay hold on this opportunity for their preſervation; of which they are not altogether judged unworthy by ſome knowing men, whoſe encouragements, to mention them to you, have diſſuaded me from wholly paſſing by, in this diſcourſe, matters properly medical, what ſcruples ſoever I had to venture at ſpeaking of them: eſpecially ſince I have not now the conveniency to furniſh theſe eſſays with divers particulars (by ſome, thought not inconſiderable) which I may, perhaps, be invited to add to them hereafter, if I find by your reception of theſe, that the others are like to be welcome.

The diviſion of phyſick in five parts.

To ſay ſomething then of phyſick, and to ſuppoſe the fitneſs of the now received diviſion of it into five parts; the phyſiological, (the phyſician taking that in a ſtricter ſenſe than philoſophers, and than we do every where, ſave in this eſſay) pathological, ſemeiotical, hygieinal, and therapeutical; let us briefly take notice, how each of theſe is indebted to, or capable of being improved by experienced naturaliſts. And indeed, ſuch is the affinity between natural philoſophy and phyſick, or the dependance of this on that, that we need not wonder at the judicious obſervation of *Ariſtotle*, where he thus writes, *Naturalium ferè plurimis & medicorum, qui magis philoſophicè artem proſequuntur, illi quidem finiunt ad ea, quæ de medicina; hi vero ex iis quæ de natura, incipiunt quæ de medicina:* ‘This is the courſe of naturaliſts and phyſicians, who proſecute ‘their art philoſophically: the naturaliſt ends where medicine begins, and medicine ‘begins where the naturaliſt endeth.’ But we muſt inſtance theſe things more particularly: and firſt for phyſiology, it is apparent, that the phyſician takes much of his doctrine in that part of his art from the naturaliſt: and to mention now no other parts of phyſiology, in its ſtricter acception, the experience of our own age may ſuffice to manifeſt, what light the anatomical doctrine of man's body may receive from experiments made on other ſubjects. For ſince it were too barbarous, and too great a violation of the laws, not only of divinity but humanity, to diſſect human bodies alive, as did *Herophilus* and *Eraſiſtratus*, who (as I find in ſome of the ancients) obtained of kings the bodies of malefactors for that purpoſe, and ſcrupled not to deſtroy man to know him; and ſince, nevertheleſs, divers things in anatomy, as particularly the motion of the blood and chyle cannot be diſcovered in a dead diſſected body (where the cold hath ſhut up and obliterated many paſſages) that may be ſeen in one opened alive; it muſt be very advantageous to a phyſician's anatomical knowledge, to ſee the diſſections of dogs, ſwine, and other live creatures, made by an inquiſitive naturaliſt: conſonantly whereunto we may remember, that the diſcoveries of the milky veſſels in the meſentery by *Aſellius*, of thoſe in the thorax by *Pecquet*, and of the *vaſa lymphatica* by *Bartholinus*, were firſt made in brute bodies, though afterwards found to hold in human ones. Nor is it a ſmall convenience to the anatomiſt, that he may in the bodies of brutes make divers inſtructive experiments, that he dares not venture on in thoſe of men; as for inſtance, that late noble, and by many not yet credited experiment, of taking out the ſpleen of a dog without killing him: for that this experiment may be very uſeful, we may elſewhere have occaſion to ſhew. And that it is poſſible to be ſafely made (though many, I confeſs, have but unproſperouſly attempted it, and it hath been lately pronounced impoſſible in print) ourſelves can witneſs. And becauſe I have not yet met with any author, that profeſſes himſelf not to relate this experiment (of the exemption of a dog's ſpleen) upon the credit of others, but as an eye-witneſs; I am content to aſſure you, that that dextrous diſſector, Dr. *Jolive* (of whom we formerly made mention) did the laſt year, at my requeſt, take out the ſpleen of a young ſetting-dog I brought him: and that it might not be pretended, the experiment was unfaithfully or favourably made, I did part of it myſelf, and held the ſpleen (which was the largeſt in proportion to his body, that ever I ſaw) in my hand, whilſt he cut aſunder the veſſels reaching to it, that I might be ſure there

*Ariſt.* lib. de ſenſu & ſenſili, cap. 1.

How the phyſiological part of phyſick is advantaged by the knowledge of natural philoſophy.

That the anatomical doctrine of man's body receives light from experiments made on other creatures.

Proved by divers inſtances: as of the finding the lacteals and lymphæducts in brute bodies firſt.

The experiment of taking out the ſpleen in dogs.

The ſame thing done by *Fiora-vanti* in a woman.

The reſpiration of frogs divers hours, ſometimes days, under water, without ſuffocation.

*Ariſt.* Hiſt. lib. I. cap. 16.

What uſe *Ariſtotle* and *Galen* made of the diſſections of brutes.

Anatomy of man counted now in *Muſcovy* for inhuman; and the uſe of ſkeletons for witchcraft.

Voyage de *Muſcovie* & de *Perſe*, p. 128.

was not the leaſt part of the ſpleen left unextirpated: and yet this puppy, in leſs than a fortnight, grew not only well, but as ſportive and as wanton as before; which I need not take pains to make you believe, ſince you often ſaw him at your mother's houſe, whence at length he was ſtolen. And though I remember the famous empirick *Fioravanti*, in one of his Italian books, mentions his having been prevailed with by the importunity of a lady (whom he calls *Marulla Græca)* much afflicted with ſplenetick diſtempers, to rid her of her ſpleen; and adds, that ſhe out-lived the loſs of it divers years: yet he, that conſiders the ſituation of that part, and the conſiderableneſs of veſſels belonging to it in human bodies, will probably be apt to think, that though his relation may be credited, his venturouſneſs ought not to be imitated. The experiment alſo of detaining frogs under water for very many hours (ſometimes amounting to ſome days) without ſuffocation, may, to him, that knows that frogs have lungs and breathe as well as other terreſtrial animals, appear a conſiderable diſcovery, in order to the determining the nature of reſpiration. Beſides, the ſcrupulouſneſs of the parents or friends of the deceaſed perſons deprives us oftentimes of the opportunities of anatomizing the bodies of men, and much more thoſe of women; whereas thoſe of beaſts are always and every where to be met with. And it was perhaps, upon ſome ſuch account, that *Ariſtotle* ſaid, that the external parts of the body were beſt known in men, the internal in beaſts; *Sunt enim* (ſays he, ſpeaking of the inward parts) *hominum imprimis incertæ atque incognitæ*; *quamobrem ad cæterorum animalium partes*, *quarum ſimiles ſunt humanæ*, *referentes eas contemplari debemus.* 'The parts of human body are unknown, and therefore we ought to conſider them by the parts of other animals, to which they are like.' And queſtionleſs in many of them, the frame of the parts is ſo like that of thoſe anſwerable in men, that he that is but moderately ſkilled in androtomy (as ſome of the moderns call the diſſection of man's body, to diſtinguiſh it from zootomy, as they name the diſſections of the bodies of other animals) may, with due diligence and induſtry, not deſpicably improve his anatomical knowledge. In confirmation of which truth, give me leave to obſerve to you, that though *Galen* hath left to us ſo many, and by phyſicians ſo much magnified anatomical treatiſes; yet not only divers of thoſe modern phyſicians, that would eclipſe his glory, deny him to have learned the ſkill he pretends to, out of the inſpection of the diſſected bodies of men or women, or ſo much as to ever have ſeen a human anatomy: but I find, even among his admirers, phyſicians, that acknowledge, that his knives were much more converſant with the bodies of apes, and other brutes, than with thoſe of men, which in his time, thoſe authors ſay, it was thought little leſs than irreligious, if not barbarous, to mangle; which is the leſs to be wondered at, becauſe even in this our age, that great people of the Muſcovites, though a Chriſtian and European nation, hath denied phyſicians the uſe of anatomy and ſkeletons; the former, as an inhuman thing; the latter, as fit for little but witchcraft, as we are informed by the applauded writer *Olearius*, ſecretary to the embaſſy lately ſent by that learned prince, the preſent duke of *Holſtein*, into *Muſcovia* and *Perſia*. And of this, the ſame author gives us the inſtance of one *Quirin*, an excellent German chirurgeon, who, for having been found with a ſkeleton, had much ado to eſcape with his life, and was commanded to go out of the kingdom, leaving behind him his ſkeleton, which was alſo dragged about, and afterwards burnt.

The uſe of the compariſon of the parts of the human body, with thoſe of beaſts.

To theſe things we may add, *Pyrophilus*, that the diligence of zootomiſts may much contribute to illuſtrate the doctrine of androtomy, and both inform phyſicians of the true uſe of the parts of an human body, and help to decide divers anatomical controverſies. For as in general it is ſcarce poſſible to learn the true nature of any creature, from the conſideration of the ſingle creature it ſelf; ſo particularly of divers parts of an human body it is very difficult to learn the true uſe, without conſulting the

Illuſtrated by divers particular obſervations.

bodies of other animals, wherein the parts inquired after is by nature either wholly left out as needleſs, or wherein its differing bigneſs, or ſituation, or figure, or connection with, and relation to other parts, may render its uſe more conſpicuous, or at leaſt, more diſcernible.

THIS truth may be ſomewhat illuſtrated by the following obſervations, which at preſent offer themſelves to my thoughts upon this occaſion.

THE lungs of vipers, and other creatures (whoſe hearts and whoſe blood, even whilſt it circulates, we have always found, as to ſenſe, actually cold) may give us juſt occaſion to inquire a little more warily, whether the great uſe of reſpiration be to cool the heart.

THE ſudden falling and continuing together, which we may obſerve in that part at leaſt of a dog's lungs, that lie on the ſame ſide with the wound, upon making a large wound in his cheſt, though the lungs remain untouched, is a conſiderable experiment, in order to the diſcovery of the principal organ of reſpiration.

IF you dexterouſly take out the hearts of vipers, and of ſome ſmaller fiſhes, whoſe coldneſs make them beat much more unfrequently and leiſurely, than thoſe of warm animals, the contraction and relaxation of the fibres of the heart may be diſtinctly obſerved, in order to the deciding or reconciling the controverſy about the cauſe and manner of the heart's motion, betwixt thoſe learned modern anatomiſts, that contend, ſome of them, for Dr. *Harvey*'s opinion; and others, for that of the Carteſians.

TOWARDS ſatisfying my ſelf in which difficulty, I remember, I have ſometimes taken the heart of a flounder, and having cut it tranſverſly into two parts, and preſſed out, and with a linnen cloth wiped off, the blood contained in each of them, I obſerved, that for a conſiderable ſpace of time, the ſevered and bloodleſs parts held on their former contraction and relaxation. And once, I remember, that I obſerved, not without wonder, that the ſevered portions of a flounder's heart did, not only after the blood was drained, move as before, but the whole heart obſerved for a pretty while ſuch a ſucceſſion of motion in its divided and exſanguious pieces, as I had taken notice of in them, whilſt they were coherent, and as you may with pleaſure both ſee and feel in the intire heart of the ſame fiſh.

SOME of the other controverſies agitated among anatomiſts and philoſophers, concerning the uſe of the heart, and concerning the principal ſeat of life and ſenſe, may alſo receive light from ſuch experiments, that we made in the bodies of brutes, as we could not of men.

Divers motions and actions of frogs after their hearts were cut out.

AND the firſt of theſe, that we ſhall mention, ſhall be an experiment, that we remember ourſelves formerly to have made upon frogs. For having opened one of them alive, and carefully cut out his heart, without cloſing up the orifice of the wound (which we had made wider than was neceſſary) the frog notwithſtanding leaped up and down the room as before, dragging his entrails (that hung out) after him; and, when he reſted, would upon a puncture leap again, and being put into the water, would ſwim, whilſt I felt his heart beating betwixt my fingers. The hearts of others of them were taken out at an inciſion, no greater than was requiſite for that purpoſe: when we had ſtitched or pinned up the wound, we obſerved them to leap more frequently and vigorouſly than the former: they would, as before they were hurt, cloſe and open their eye-lids upon occaſion. Being put into a veſſel not full of water, they would as orderly diſplay their fore and hinder legs in the manner requiſite to ſwimming, as if they wanted none of their parts, eſpecially not their hearts; they would reſt themſelves, ſometimes upon the ſurface of the water, ſometimes at the bottom of it; and ſometimes alſo they would nimbly leap, firſt out of the veſſel, and then about the room, ſurviving the exſection of their hearts, ſome about an hour, and ſome longer. And that, which was further remarkable in this experiment, was, that we could, by gently preſſing their breaſt and belly with our fingers, make them, almoſt at pleaſure, make ſuch a noiſe, as to the by-ſtanders made them ſeem to croak. But how this experiment will be reconciled to the doctrine aſcribed to Mr. *Hobbes*, or to that of the Ariſtotelians, who tell us, that their maſter taught the heart to be the ſeat of ſenſe (whence alſo, though erroneouſly, he made it the original of the nerves) let thoſe, that are pleaſed to concern themſelves to maintain all his opinions, conſider.

Obſervations of the motion of a chicken's heart, after the head and other parts were cut off.

AND whereas frogs, though they can move thus long without the heart, yet they cannot at all bear the exemption or ſpoiling of the brain; we will add what we have obſerved, even in hot animals, whoſe life is conceived to be much more ſuddenly diſſipable, and the motion of each part much more dependent upon the influence of the brain: we opened then an egg, wherein the chick was not only perfectly formed, but well furniſhed with feathers; and having taken him out of the membrane, that involved him, and the liquors he ſwam in, and laid him on his back on a flat piece of glaſs, we clipped away, with a pair of ſciſſors, the head and the breaſt-bone; whereby the heart became expoſed to view, but remained faſtened to the headleſs trunk: and the chick lying in this poſture, the heart continued to beat above a full hour, and the ears ſeemed to retain their motion a pretty while after the heart it ſelf had loſt his; the motion of none of the other parts appearing many moments to ſurvive the loſs of the head: and, which is moſt conſiderable, the ſeemingly dead heart was divers times excited to new, though quickly ceaſing motion, upon the puncture of a pin, or the point of a pen-knife. And to evince, that this was no caſual thing, the next day we dealt with the chick of another egg, taken from the ſame hen, after the above-recited manner; and when the motion of the heart and ears began to ceaſe, we excited it again, by placing the glaſs over the warm ſteam of a veſſel full of hot water, bringing ſtill new water from off the fire to continue the heat, when we perceived the former water to begin to cool, and by this means we kept the heart beating for an hour and an half by meaſure. And at another time for further ſatisfaction, we did, by theſe and ſome other little induſtries, keep the heart of a ſomewhat elder chick, though expoſed to the open air, in motion, after we had carefully clipped off the head and neck, for the ſpace of (if our memory do not much miſ-inform us) two hours and a half by meaſure. Upon what conjectures we expected ſo laſting a motion in the heart of a chick, after it had loſt the head, and conſequently the brain, would be more tedious and leſs fit to be mentioned in this place, than the ſtrange vivacity we have ſometimes, not without wonder, obſerved in vipers: ſince not only their hearts clearly ſevered from their bodies may be obſerved to beat for ſome hours (for that is common with them to divers other cold animals) but the body it ſelf may be, ſometimes, two or three days after the ſkin, heart, head, and all the entrails are ſeparated from it, ſeen to move in a twining or wriggling manner: nay (what is much more) may appear to be manifeſtly ſenſible of punctures, being put into a freſh and vivid motion, when it lay ſtill before, upon the being pricked, eſpecially on the ſpine or marrow, with a pin or needle.

Of the vivacity of diſſected vipers,

And tortoiſes.

AND though tortoiſes be in the *Indies* many of them very large animals, yet that great traveller *Vincent le Blanc*, in his *French Voyages*, giving a very particular account of thoſe tortoiſes, which the Eaſt-Indian king of *Pegu*, (who was much delighted with them) did, with great curioſity, cheriſh in his ponds, adds this memorable paſſage as an eye-witneſs of what he relates: *When the king hath a mind to eat of them, they cut off their heads, and five days after they are prepared; and yet after thoſe five days they are alive, as we have often experienced.* Now although I will not ſay, that theſe experiments prove, that either it is in the membrane, that ſenſation reſides (though I have ſometimes doubted, whether the nerves themſelves be not ſo ſenſible, chiefly as they are inveſted with membranes) or that the brain may not be confined to the head, but may reach into the reſt of the body, after another manner than is wont to be taught; yet it may be ſafely affirmed, that ſuch experiments as theſe may be of great concernment in reference to the common doctrine of the neceſſity of unceaſing influence from the brain, being ſo requiſite to ſenſe and motion; eſpecially if to the lately mentioned particulars we add, on this occaſion, what we have obſerved of the butterflies, into which ſilk-worms have been metamorphoſed; namely, that they may, not only, like common flies, and divers other winged inſects, ſurvive a pretty while the loſs of their heads, but may ſometimes be capable of procreation after having loſt them: as I not long ſince tried (though not, perhaps, without ſuch a reluctancy as *Ariſtotle* would have blamed in a naturaliſt) by cutting off the heads of ſuch butterflies of either ſex. *Quamvis enim mas, cui prius amputatum eſt caput, nequaquam adduci poſſet (quæcunque inſecti illius eſt ſalacitas) ut fœminam comprimeret, decollata tamen fœmina marem alacriter admiſit. Et licèt poſt horas aliquot coitu inſumptas ita requierit immota, ut mortuam per multas horas cogitarem, non ſolùm quia omnem penitus motum perdiderat, & in thorace ſatis magnum apparebat foramen, quod à parte aliqua corporis ſimul cum capite à trunco diſruptâ factum videbatur; verum etiam quoniam eodem permanſit ſtatu, idque per plures horas, ultra tempus, quo poſt coitionem cum mare hujus generis animalcula ſolent ordiri prolificationem. Tandem verò poſtquam jam diu de vita ejus deſperatum eſſet, ova fœtare tam confertim cœpit, ut vel exiguo temporis intervallo eorum plura in manu mea deponeret. An verò prolifica ſint futura, nondum comperi.*

Whether there be a neceſſity of the unceaſing influence of the brain to ſenſe and motion.

That the ſilk-worm butterfly is capable of procreation after the loſs of its head.

THEIR opinion, that aſcribe the redneſs of the blood to the colour of the liver, through which it paſſes, is not diſcountenanced by the livers of men: but in hen-eggs, about the third or fourth day after incubation (for we have found the circumſtances of time much to vary) you may obſerve the *punctum ſaliens*, or heart, to be ever and anon full of conſpicuouſly red blood, before the naked eyes can ſo much as diſcern a liver, at leaſt before they can diſcover in it any redneſs; a yellowneſs being all I could obſerve in the parenchyma of the livers of divers chickens perfectly formed, and furniſhed with feathers, though not great enough to make their way out of the ſhell. And in divers great fiſhes I have found the veſſels of the liver full of very red blood, though the parenchyma or ſubſtance of it were white, or at leaſt did not at all participate, much leſs impart a ſanguine colour.

That the redneſs of the blood is not to be aſcribed to the liver, proved by the inſpection of the liver of chickens unhatched.

THE doctrine ſo unanimouſly delivered by phyſicians and chirurgeons, concerning the irreparable loſs of the limb of an animal, once violently ſevered from the body, will appear unfit to be admitted, without ſome reſtriction, by what may be experienced in lizards, in lobſters, and craw-fiſhes, and perhaps in ſome other living creatures. For of lizards it hath been often obſerved in hot countries, and even in *France*, that their tails being ſtruck off will grow again. And the like hath been of old obſerved by *Pliny*; and the experienced *Bontius* delivers it upon his own knowledge in theſe words: *Hoc in domeſticis meis non ſemel animadverti, dum filioli mei luſitabundi bacillo caudas iis decutiebant, quas tamen poſt diem unum aut alterum ad ſolitum pabulum revertentes vidi, caudaſque iis paulatim reaccreſcere:* 'This I have more than once obſerved in lizards, 'which I kept in my own houſe. For my children being at play, when with a rod 'they had ſtruck off the lizards tails, I ſaw them within a day or two come out to feed, 'and their tails then by little and little ſtill increaſing and growing bigger.'

That the loſs of a limb in all animals is not irreparable.

THAT the claws likewiſe of lobſters being torn off, another will ſometimes grow in the room of it, is not only ſaid by fiſhermen, but hath been affirmed to me by very credible perſons, one of which aſſured me, that he himſelf had obſerved it very often. And I am the more apt to believe it, becauſe the like is to be met with among craw-fiſhes, which are ſo like lobſters, that by many they are taken (though not conſiderately

derately enough) to be but a ſmaller kind of them. For I remember, that going to look upon a repoſitory, where a multitude of them was kept, and cauſing divers of the faireſt to be thrown up, that I might take the ſtony concretions, commonly called *oculi cancrorum*, out of their heads, I obſerved one large fiſh, that had one of his claws proportionable to the bulk of his body, but the other ſo ſhort and little, that the greater ſeemed to be four or five times as big as it; whereupon its good ſhape and freſh colour ſeeming to argue it to be but young and growing, invited me to aſk one of them, that had the overſight of the fiſh, whether he had formerly ſeen any claws torn off grow again, he affirmed to me, that in that ſort of fiſh it was very uſual.

That notwithſtanding the great ſolution and digeſtion of meat in the ſtomachs of fiſhes, no ſenſible acidity is found there.

I COULD alſo tell you, how fruitleſly I have endeavoured to diſcover that ſtomachical acidity, to which many of our modern phyſicians are pleaſed to aſcribe the firſt digeſtion of the nutriment of animals, in the purpoſely diſſected ſtomachs of ravenous ſea-fiſhes; in whoſe ſtomachs, though our taſte could not perceive any ſenſible acidity, yet we found in one of them a couple of fiſhes, each of them about a foot long: whereof the one, which ſeemed to have been but newly devoured, had ſuffered little or no alteration in the great fiſh's ſtomach; but the other had all its outſide, ſave the head, uniformly waſted to a pretty depth, beneath the former ſurface of the body, and looked as if it had been not boiled, or wrought upon by any conſiderable heat, but uniformly corroded, like a piece of ſilver coin kept a while in aqua fortis, according to the criminal tricks of adulterators of money.

Experiments concerning the ſolution of meats, and their change of colours by acid menſtruums.

YET I am loth, till I have perfected what I deſign in order to that inquiry, either to embrace or reject the opinion I find ſo general among the moderns, concerning the ſolution of meat in the ſtomach by ſomething of acid. And I remember, that when I was conſidering what might be alledged for, as well as againſt that opinion, I deviſed this experiment, among others, in favour of it. I provided a liquor, with which I drenched a piece of a wing of a pullet, having firſt well cruſhed it between my fingers, to make ſome amends for the omiſſion of chewing it; and having a little incorporated the liquor and the muſculous fleſh, they immediately changed colour, and in about an hour grew to be a kind of jelly, in colour and conſiſtence not unlike quince marmalade. This mixture, by the next morning, did, as I expected, turn to a deep blood-red, or ſometimes rather a lovely purple liquor, though all his while there had been no external heat imployed to promote the action of the menſtruum. And the like experiment I tryed alſo with a piece of mutton, with bread, and a piece of veal, and other edible things, which at that time occurred to me; and found the operation of the liquor almoſt uniform, though it ſeemed to act moſt effectually upon fleſh. And to gratify in ſome meaſure your curioſity, *Pyrophilus*, I am content to tell you, that the menſtruum was drawn from vitriol, and that with the bare oil of it I have (though I could not with aqua fortis) performed no leſs than what I have yet mentioned: but leſt this ſhould be thought a digreſſion, let it ſuffice to have, on this occaſion, mentioned thus much upon the by.

To what we lately took notice of concerning the heart may be added, that on the ſea-coaſt of *Ireland*, I obſerved a ſort of fiſhes about the bigneſs of mackrels, whoſe hearts were of an inverted figure, compared to thoſe of other animals; the baſis or broad end of the heart being neareſt the tail, and the acuminated part or apex being coherent to the great artery, and reſpecting the head.

To all theſe trifling obſervations divers more conſiderable ones might be added, but they may be more ſeaſonably inſiſted on elſewhere; and thoſe already mentioned may ſuffice to let you ſee, that the naturaliſt his zootomy may be very ſerviceable to the phyſician in his anatomical inquiries.

NOR is it only by the diſſection of various animals, that the naturaliſt may promote the anatomiſt's knowledge, but perhaps alſo he may do it by deviſing ways to make the dead bodies of men, and other animals, keep longer than naturally they would do. For ſince experience teaches us, that men find it very eaſy to forget the originations, windings, branchings, inſertions, and other circumſtances of particular veſſels, and other parts of the body, as well as thoſe, that ſtudy botanicks, are wont to complain of their eaſy forgetting the ſhapes, differences, and alterations of ſmaller plants; it cannot but be a great help to the ſtudent of anatomy to be able to preſerve the parts of human bodies, and thoſe of other animals, eſpecially ſuch monſters, as are of a very ſingular or inſtructive fabrick, ſo long, that he may have recourſe to them at pleaſure, and contemplate each of them ſo often and ſo conſiderately, till he have taken ſufficient notice of the ſhape, ſituation, connection, *&c.* of the veſſel, bone, or other part, and firmly impreſſed an idea of it upon his memory. We find our ſelves much helped to retain in our memory the figures and differences of vegetables, by thoſe books, which ſome curious botaniſts make, wherein the plants themſelves, artificially dried, are diſplayed upon, and faſtened to leaves of white paper. If it were not for one of thoſe books, wherein I have in one vaſt volume almoſt all the plants of one of the chief phyſick gardens in *Europe*, I ſhould every year forget, by the end of winter, to know again moſt of the ſmaller plants I had learned to take notice of in the ſpring. And by the way it is obſervable, how long plants, by being carefully indeed, but barely dried in the ſhade betwixt ſheets of paper, which help to ſoak up the ſuperfluous moiſture, may be preſerved. For I have divers years had an herbal, wherein ſeveral of the flowers, and other plants, retain their native yellow and blue, *&c.* (but ſomewhat faint) though by the date it appeared to be 22 or 23 years old. And I am apt to think, that it would be very poſſible for anatomiſts alſo to preſerve the bodies they contemplate for a conſiderable time: for experience hath informed us in good number of ſuch animals, that butterflies, and divers other flying inſects, may have their ſhape and colours preſerved, I know not how long, by running them through in ſome convenient part with pins, and therewith ſticking them to the inſide of large boxes. And on this occaſion, I remember, that having ſometimes reflected upon the laſting of ſpiders, flies, and other ſmall living creatures, that having been caſually encloſed in amber whilſt it was ſoft, are ever preſerved entire and uncorrupted, I thought it not amiſs to try, whether ſome ſubſtance, like amber (at leaſt as to the newly mentioned uſe of it) might not eaſily be prepared by art. And hereupon I quickly found, that by taking good clear *Venice* turpentine, and gently evaporating away about a third part of it, (ſometimes more, ſometimes leſs, according to the exigency of my particular purpoſe;) I could make a reddiſh gum, diaphanous and without bubbles, which would melt with a very gentle heat, and eaſily (being ſuffered to cool) become again ſo hard as to be brittle. This reſinous ſubſtance ſhould be melted with as little heat as is poſſible, (and therefore ſhould be firſt powdered) that the texture of the vegetable or animal bodies to be caſed over with it, might receive the leſs alteration: and when it is brought to the requiſite degree of fluidity, then the body to be preſerved (being, if that be needful, ſtruck through with a pin) muſt be gently plunged into it, and preſently taken out and ſuffered leiſurely to cool, being turned from time to time this way or that way, if there be occaſion, that the inveſting matter may be every where of an equal thickneſs upon it. And if at the firſt time the caſe be not thick enough, it may again, when it is cold, be immerſed into the liquid matter, (as chandlers are wont to thicken their candles, by dipping them frequently into melted tallow) of which ſome will every way adhere to it. And though theſe caſes be inferiour to amber, in regard of their being more apt to be ſullied by duſt, or otherwiſe; yet that inconvenience may be eaſily

Ways of artificial drying and preſervation of plants.

And inſects.

remedied, by keeping them ſhut up in glaſſes or boxes, at thoſe times, when one hath not occaſion to conſider them. And their clearneſs (eſpecially if they be thin) and their ſmooth ſurfaces, together with their exactly keeping out the air from the body they encloſe, may, perhaps, make ſo cheap and ſo eaſy an experiment a not unwelcome trifle, eſpecially conſidering, how eaſily it is capable of improvement.

**And more bulky bodies.**

BUT to return to the preſervation of more bulky bodies, it is a known thing to the collectors of rarities, that the external idea of fiſhes, crocodiles, birds, and even horſes, may be preſerved for many years, by taking out the more corruptible parts, and ſtuffing their prepared ſkins with any convenient matter. And that the internal membranous parts of bodies may be long and eaſily kept from putrefaction, is not unknown to many anatomiſts. And not to mention what we have tried of this ſort, we have ſeen the veins, arteries, and nerves of a human body, laid out in their natural ſituation upon three boards, by the pains and ſkill of an accurate anatomiſt of *Padua*. And elſewhere, *Uterum vidimus atque omnia mulieris genitalia*, together with the bladder, all diſplayed upon a board, preſerved for many years ſo entire, and in a ſituation ſo near the natural, that this ſcheme was far more inſtructive, than the moſt accurate printed one could poſſibly be. We have likewiſe known the fleſh of vipers, kept not only ſweet but efficacious, for divers years, by the ſmoke of a peculiar powder, chiefly conſiſting of aromatick ingredients, and of which you, *Pyrophilus*, may command the compoſition.

**Particularly the ſchemes of divers parts of human body.**

WE have alſo ſeen the ſkeleton of a monkey, made by an excellent French chirurgeon of our acquaintance, whereon the tendons and fibres of the muſcles were ſo preſerved, that it was looked upon as a rarity, very uſeful to ſhew their originations and inſertions, and to explain the motions of the limbs: and perhaps there may be ſome way to keep the arteries and the veins too, when they are emptied of blood, plump, and unapt to ſhrink overmuch, by filling them betimes with ſome ſuch ſubſtance, as, though fluid enough when it is injected to run into the branches of the veſſels, will afterwards quickly grow hard. Such may be the liquid plaiſter of burnt alabaſter, formerly mentioned, or iſing-glaſs ſteeped two days in water, and then boiled up, till a drop of it in the cold will readily turn into a ſtill gelly. Or elſe *ſaccharum ſaturni*, which, if it be diſſolved often enough in ſpirit of vinegar, and the liquor be each time drawn off again, we have obſerved to be apt to melt with the leaſt heat, and afterwards to grow quickly into a ſomewhat brittle conſiſtence again. But I muſt not inſiſt on theſe fancies, but rather add, that I have known an embryo, wherein the parts have been very perfectly delineated and diſtinguiſhable, preſerved unputrified for ſeveral years; and I think it ſtill continues ſo, by being ſeaſonably and artificially embalmed with oil (if I much miſremember not) of ſpike. And I have elſewhere ſeen a large embryo, which after having been preſerved many years, by means of another liquor (whoſe compoſition I do as yet but gueſs at) did, when I ſaw it, appear with ſuch an admirable entireneſs, plumpneſs, and freſhneſs, as if it were but newly dead: and that which concurs to make me hope, that ſome nobler way may be yet found out, for the preſervation of dead bodies, is, that I am not convinced, that nothing can powerfully reſiſt putrefaction in ſuch bodies, but things, that are either ſaline and corroſive, or elſe hot; nor that the embalming ſubſtances cannot be effectually applied, without ripping open the body to be preſerved by them. For *Joſephus Acoſta*, a ſober writer, relates, that in certain American mountains, men, and the beaſts they ride on, ſometimes are killed with the winds, which yet preſerve them from putrefaction, without any other help. So inſenſible a quantity of matter, ſuch as it may be, may, without inciſion made into the body, both pervade it, and as it were embalm it. I know alſo a very experienced and ſober gentleman, who is much talked of, for curing of cancers in womens breaſts, by the outward application of an indolent powder, ſome of which he alſo gave me, but I

have

**Of the preſervation of an embryo divers years, by embalming it with oil of ſpike.**

**Inſtances of men in the *American* mountains killed, and afterwards preſerved from putrefaction, only by the wind.**

have not yet had the opportunity to make trial of it. And I ſhall anon tell you, that I have ſeen a liquor, which, without being at all either acid or cauſtick, is in ſome bodies far more effectual againſt putrefaction, than any of the corroſive ſpirits of nitre, vitriol, ſalt, *&c.* and than any of the other ſaline liquors, that are yet in uſe. We have alſo tried a way of preſerving fleſh with muſk, whoſe effects ſeemed not deſpicable to us, but muſt not here be inſiſted on.

Of the uſe of ſpirit of wine, for the preſervation of bodies from putrefaction.

NOR were it amiſs, that diligent trial were made, what uſe might be made of ſpirit of wine, for the preſervation of a human body. For this liquor being very limpid, and not greaſy, leaves a clear proſpect of the bodies immerſed in it; and though it do not fret them, as brine, and other ſharp things, commonly imployed to preſerve fleſh, are wont to do; yet it hath a notable balſamick faculty, and powerfully reſiſts putrefaction, not only in living bodies (in which, though but outwardly applied, it hath been found of late one of the potenteſt remedies againſt gangrenes) but alſo in dead ones. And I remember, that I have ſometimes preſerved in it ſome very ſoft parts of a body for many months (and perhaps I might have done it for divers years, had I had opportunity) without finding, that the conſiſtence or ſhape was loſt, much leſs, that they were either putrified or dried up: we have alſo, by mixing with it ſpirit of wine, very long preſerved a good quantity of blood, ſo ſweet and fluid, that it was wondered at by thoſe, that ſaw the experiment. Nay, we have for curioſity ſake, with this ſpirit, preſerved from further ſtinking a portion of fiſh, ſo ſtale, that it ſhined very vividly in the dark; in which experiment, we alſo aimed at diſcovering, whether this reſplendent quality of the decaying fiſh would be either cheriſhed or impaired by the ſpirit of wine, (whoſe operations in this trial, we elſewhere inform you of) and it would be no very difficult matter for us to improve, by ſome eaſy way, this balſamical virtue of ſpirit of wine, in caſe you ſhall think it worth while. But not to anticipate what I may more properly mention to you elſewhere, I ſhall at preſent ſay no more touching the conſervation of bodies, ſince probably by all theſe, and ſome other particulars, we may be induced to hope ſo well of human induſtry, as not to deſpair, that in time ſome ſuch way of preſerving the bodies of men, and other animals, will be found out, as may very much facilitate, and advance too, anatomical knowledge. Neither is it only by advancing this, that the naturaliſt may promote the phyſiological part of phyſick: for ſince the body conſiſts not only of firm and conſtant parts, as the bones, muſcles, heart, liver, *&c.* but of fluid ones, as the blood, ſerum, gall, and other juices; and ſince conſequently to the complete knowledge of the uſe of all the parts, we ſhould inveſtigate not only the ſtructure of the ſolid ones, but the nature of the fluid ones; the naturaliſt may do much more than hath yet been done, towards the perfecting of this knowledge, not only by better explicating what it is in general, makes bodies either conſiſtent or fluid, but by examining particularly, and eſpecially in a pyrotechnical way, the nature of the ſeveral juices of the body, and by illuſtrating the alterations, that thoſe juices, and the aliments they are made of, receive in the ſtomach, heart, liver, kidneys, and other viſcera. For although a human body, being the moſt admirable corporeal piece of workmanſhip of the omniſcient Architect, it is ſcarce to be hoped, but that even among the things, that happen ordinarily and regularly in it, there will be many, which we ſhall ſcarce be able to reach with our underſtanding, much leſs to imitate with our hands: yet peradventure, if chymical experiments, and mechanical contrivances, were induſtriouſly and judiciouſly aſſociated by a naturaliſt profoundly ſkilled in both, and would make it his buſineſs to explain the phænomena of a human body, not only many more of them, than at firſt one would think, might be made more intelligible than as yet they have been; but divers of them (eſpecially thoſe relating to the motions of the limbs and blood) might be by

That the examination of the juices of human body, by the art of chirurgery, may illuſtrate their uſe and nature.

That the actions, which are common to men, with other animals, being performed mechanically, the ſkill of mechanicks muſt be of uſe to phyſiology.

artificial engines (conſiſting as the pattern not only of ſolid, but liquid and ſpirituous parts) not ill repreſented to our very ſenſes: ſince a human body it ſelf ſeems to be but an engine, wherein almoſt, if not more than almoſt, all the actions common to men with other animals are performed mechanically. But of the difference of theſe living engines from others, I may elſewhere have a fitter opportunity to diſcourſe to you. For at preſent, *Pyrophilus*, I have employed ſo much of the little time my occaſions will allow me to ſpend upon the treatiſe I am now writing, in making out to you the uſefulneſs of natural philoſophy to the phyſiological part of phyſick, that I muſt not only not proſecute this ſubject, but muſt both haſten to mention, and to mention the more curſorily its ſerviceableneſs to the four remaining parts of the phyſician's art.

## ESSAY II.

### *Offering ſome particulars relating to the Pathological part of Phyſick.*

That the naturaliſt's knowledge may aſſiſt the phyſician to diſcover the nature and cauſes of diſeaſes.

Proved by general reaſon.

AND to ſay ſomething in the next place of pathology, that the naturaliſt's knowledge may aſſiſt the phyſician to diſcover the nature and cauſes of ſeveral diſeaſes, may appear by the light of this conſideration, that though divers Paracelſians (taught, as they tell us, by their maſter) do but erroneouſly ſuppoſe, that man is ſo properly a microcoſm, that of all the ſorts of creatures, whereof the macrocoſm or univerſe is made up, he really conſiſts; yet certain is it, that there are many productions, operations, and changes of things, which being as well to be met with in the great, as in the little world, and divers of them diſcloſing their natures more diſcernibly in the former, than in the latter; the knowledge of the nature of thoſe things, as they are diſcoverable out of man's body, may well be ſuppoſed capable of illuſtrating many things in man's body, which receiving ſome modifications there from the nature of the ſubject they belong to, paſs under the notion of the cauſes or the ſymptoms of diſeaſes. If I were now, *Pyrophilus*, to diſcourſe to you at large of this ſubject, I think I could convince you of the truth of what I have propoſed. And certainly, unleſs a phyſician be (which yet I fear every one is not) ſo much a naturaliſt, as to know, how heat and cold, and fluidity, and compactneſs, and fermentation, and putrefaction, and viſcoſity, and coagulation, and diſſolution, and ſuch like qualities, are generated and deſtroyed in the generality of bodies, he will be often very much to ſeek, when he is to inveſtigate the cauſes of preternatural accidents in men's bodies; whereof a great many depend on the preſence, or change, or vaniſhing of ſome or other of the enumerated qualities, in ſome of the fluid or ſolid ſubſtances that conſtitute the body. And that the explications of a ſkilful naturaliſt may add much to what has hitherto commonly been taught concerning the nature and origin of thoſe qualities in phyſicians ſchools, a little comparing of the vulgar doctrine with thoſe various phænomena, to be met with among natural things, that ought to be, and yet ſeem not to be, explicable by it, will eaſily manifeſt to you. And queſtionleſs it is a great advantage to have been taught, by variety of experiments in other bodies, the differing ways, whereby nature ſometimes produces the ſame effects. For ſince we know very little *à priori*, the obſervation of many ſuch effects, manifeſting, that nature doth actually produce them ſo and ſo, ſuggeſts to us ſeveral ways of explicating the ſame phænomenon, ſome of which we ſhould perhaps never elſe have dreamed of. Which ought to be eſteemed no ſmall advantage to the phyſician; ſince he, that knows but one or few of nature's ways of working, and conſequently is likely to ignore divers of thoſe, whereby the propoſed diſeaſe (or ſymptom of it) may be produced, muſt ſometimes conclude, that preciſely ſuch or ſuch a thing is the determinate cauſe of it, and apply his method of relieving his patient accordingly; which often proves very prejudicial to the poor patient, who dearly pays for his phyſician's not knowing, that the quality, that occaſions the diſtemper, may be as probably, if not more rationally, deduced from another origin, than from that, which is preſumed. This will ſcarce be doubted by him, that knows how much more likely explications than thoſe applauded ſome ages ſince, of divers things, that happen as well within as without the body, have been given by later naturaliſts, both philoſophers and phyſicians: and how much the theory of the ſtone, and many other diſeaſes, that has been given us by thoſe many phyſicians, that would needs deduce all the phænomena of diſeaſes from heat, cold, and other elementary qualities, is inferiour to the account given us of them by thoſe ingenious moderns, that have applied to the advancement of pathology, the circulation of the blood, the motion of the chyle by the milky veſſels to the heart, the conſideration of the effects deducible from the pores of greater bodies, and the motion and figuration of the minute parts, together with ſome of the more known chymical experiments: though both of thoſe, and of the other helps mentioned juſt before them, I fear men have hitherto been far enough from making the beſt uſe, which I hope it will daily more and more appear they are capable of being put to. He that has not had the curioſity to inquire out, and conſider the ways, whereby ſtones may be generated out of the body, not only muſt be unable ſatisfactorily to explicate how they come to be produced in the kidneys and in the bladder, but will, perhaps, ſcarce keep himſelf from embracing ſuch errors, becauſe authorized by the ſuffrage of eminent phyſicians, as the knowledge I am recommending would eaſily protect them from. For we find divers famous, and, otherwiſe, learned doctors, who (probably becauſe they had not taken notice of any other way of hardening a matter, once ſoft, into a ſtone-like conſiſtence) have believed and taught that the ſtone of the kidneys is produced there by ſlime baked by the heat and dryneſs of the part; as a portion of ſoft clay may, by external heat, be turned into a brick or tile. And accordingly they have, for cure, thought it ſufficient to make uſe of ſtore of remedies to moiſten and cool the kidneys; which, though in ſome bodies this be very convenient, are yet far inferiour in efficacy to thoſe nobler medicines, that by ſpecifick qualities and properties are averſe to ſuch coagulations as produce the ſtone. But (not to mention what a phyſician ſkilled in anatomy would object againſt this theory from the nature of the part affected) it is not unlike, the embracers of this hypotheſis would not have acquieſced in it, if they had ſeen thoſe putrefactions out of the bodies of men, which we elſewhere mentioned. For thoſe would have informed them, that a liquor abounding with petreſcent parts may not only turn wood (as I have obſerved in a petrifying ſpring) into a kind of ſtone, and may give to cheeſe and moſs, without ſpoiling their priſtine appearance, a ſtrong hardneſs and weight; but may alſo produce large and finely ſhaped cryſtalline bodies (though thoſe I tried were much leſs hard than cryſtal) in the boſom of the cold water. Which brings into my mind, that I have divers times produced a body of an almoſt ſtony hardneſs in leſs than half an hour, even in the midſt of the water, by tying up in a rag, about the quantity of a nutmeg of well and recently calcined alabaſter, which being thus tied up and thrown into the bottom of a baſon full of water, did there ſpeedily harden into lapideous concretion. And that even in the bodies of animals themſelves, ſuch concretions may be generated much otherwiſe, than

By particular inſtances of the cauſe of the ſtone in the kidneys.

The cauſe of that diſeaſe illuſtrated by the putrefaction of wood, cheeſe, moſs, water, &c.

the hypotheſis we have been ſpeaking of ſuppoſes, may appear by what happens to craw-fiſhes, which though cold animals, and living in the waters, have generated at certain ſeaſons in their heads, concretions, which for their hard and pulverizable conſiſtence, divers authors called *lapides cancrorum*, though in the ſhops they are often, but abuſively ſtyled *oculi cancrorum*. And ſuch ſtrong concretions are affirmed to be generated in theſe fiſhes every year, which I the leſs ſcrupled at, becauſe I have not found them at all times in the head of the fiſh. And beſides theſe and many more concretions, that had they been obſerved by the phyſicians we have been ſpeaking of, might eaſily have kept them from acquieſcing in, and maintaining their improbable explication of the manner of the ſtone's nativity; there is yet another kind of coagulation, which may both be added to the former, and perhaps alſo may ſerve to recommend the uſe of chymical experiments, inveſtigating the cauſes of diſeaſes. This is made by the mixture of exquiſitely dephlegmed ſpirit of fermented human urine, with as exactly rectified ſpirit of wine: for upon the confuſion of thoſe two volatile liquors in a juſt proportion, they will both of them, as after *Lullius*, experience hath informed us, ſuddenly coagulate into a white maſs, which *Helmont* calls *Offa Alba*, and by which he endeavours to declare the procreation of the *Duelech*. For ſuppoſing himſelf to have found in human urine a potential *aqua vitæ*, or vinous ſpirit, capable of being excited by a putrid ferment, and coagulable by the volatile ſalt of the ſame urine, if there were any volatile earth lurking in the liquors; that being apprehended by the uniting ſpirits, and coagulated with them both, he ſuppoſeth there may emerge from the union of thoſe three bodies, ſuch an anomalous concretion, as he, after *Paracelſus*, calls *Duelech*.

The origin of *Helmont*'s Alba Offa, and *Paracelſus*'s Duelech, by the mixture of ſpirit of wine and ſpirit of urine, an example of the generation of the ſtone. *Helmont.* de Lith. cap. 3 & 4.

AND that a ſubtile terreſtrious ſubſtance may lurk undiſcerned, even in limpid liquors, may appear not only in wine, which rejects and faſtens to the ſides of the containing veſſel, a tartar, abounding in terreſtrious feculency; and in common urine of healthy men, which, though clear, at its firſt emiſſion into the urinal, does, after a little reſt there, let fall an hypoſtaſis, or ſediment, which, if diſtilled before fermentation, leaves in the bottom of the cucurbit an earthy ſubſtance, and commonly ſome gravel: but even in rectified ſpirit of urine it ſelf I have had opportunity to obſerve, that after very long keeping, there hath ſpontaneouſly precipitated a feculency, copious enough in proportion to the liquor, that afforded it. Nay, in another parcel of ſpirit of urine, that hath been kept much longer than that already mentioned, we obſerved the other day, that not only there was a terreſtrial reſidence fallen to the bottom of the glaſs; but to the ſides of it, as far as the liquor reached, there adhered a great multitude of ſmall concretions; which, as far as appeared by looking on them through the cryſtal phial, to whoſe inſides they are faſtened, were no other than little grains of gravel, ſuch as are often found ſticking to the inſides of urinals, employed by calculous perſons.

That a terreſtrious ſubſtance may lurk undiſcerned in limpid liquors.

To which we might add an experiment of ours, whereby we are wont almoſt in a moment, by barely mixing together a couple of liquors both of them diſtilled and tranſparent, and yet not both of them ſaline, to thick them very notably and permanently, inſomuch that they ſeem not to precipitate each other; yet having once, for curioſity-ſake, diſtilled them with a pretty ſtrong fire, I obtained a great quantity (as I remember, a fourth of the whole mixture) of a blackiſh maſs, that was not only coagulated and dry, but even brittle. But of the coagulation of diſtilled liquors, ſuch as even chymiſts themſelves are not wont to look upon as at all diſpoſed to coagulation, I may elſewhere have a better opportunity to entertain you, and therefore I ſhall forbear to do it now.

AND by this way, *Pyrophilus*, doth *Helmont*, if I underſtand him aright, attempt to make out the generation of the ſtone in human bodies: in which theory though ſome difficulties do yet keep me from acquieſcing, yet beſides that, perhaps what you will meet with by and by (about the diſtillation of the *Duelech*) may make you the leſs wonder at this explication; beſides this, I ſay, granting that none of the enumerated ways of petreſcency (if I may ſo ſpeak) deſerve to be looked upon as ſatisfactory; yet to give ſo much as an account not very abſurd, of a diſeaſe ſo anomalous and abſtruſe, and hitherto ſo unluckily explicated by phyſicians, is perhaps more difficult, than it were to give (at leaſt) a plauſible account of divers other diſtempers.

The uſe of chymiſtry in explaining the nature of, and aberrations in our digeſtions.

AND poſſibly it may be ſafely enough affirmed, that not only phyſiology, in its full extent, but that handmaid to it, which is called chymiſtry, may not a little contribute to clear up the nature of both of the digeſtions, and of thoſe deficiencies or aberrations in them, which produce a great part of diſeaſes; eſpecially if we allow what, as well phyſicians, as Spagyriſts agree in, (whether warily enough or not, I ſhall not now diſpute) *viz.* that whatever is ſeparable from bodies by the fire, was, as a conſtituent element (or principle) pre-exiſtent in them.

PERHAPS I need not mind you, *Pyrophilus*, that it is uſual with the merely Galenical doctors themſelves to explicate the nature of catarrhs, by comparing the ſtomach to a ſeething-pot, and the head to an alembick, where the aſcending vapours, being, by the coldneſs of the brain, condenſed into a liquor, ſometimes diſtil upon the lungs, and ſometimes fall upon other weakened parts: in which explication though for divers reaſons I cannot acquieſce, yet it may ſuffice to ſhew you, how little ſcruple many learned men, not like to to be partial in the caſe, would make of employing chymical operations to illuſtrate the doctrine of diſeaſes. And indeed, ſince the liquors contained in the body abound, divers of them, with ſaline or ſulphureous parts, he, that hath been by chymiſtry taught the nature of the ſeveral ſorts of ſalts and ſulphurs, and both beheld and conſidered their various actions upon one another, and upon other bodies, ſeems to have a conſiderable help to diſcourſe groundedly of the changes and operations of the humours, and other juices contained in the body, which he hath not, that hath never had *Vulcan* for his inſtructor. He that finds, that there may be acid juices in the ſtomach, and elſewhere, (as is frequently evident in the ſharp liquors, which many ſtomachs caſt up) and that there are alſo ſulphureous ſalts in the body (as is apparent in blood and urine, which abounds with ſuch:) He that knows that the ſerum, that ſwims upon the blood out of the body, is by a gentle heat immediately coagulable into a thick whitiſh ſubſtance, not unlike a cuſtard; and that chymically analyzed blood yields ſtore of volatile ſulphureous, but (as far as our trials have hitherto informed us) no acid, ſaltneſs:

Proved by a catalogue of conſiderable obſervations.

HE that knows, that theſe animal ſalts and ſpirits may be ſo powerful, that we have been able with ſpirit of urine, or of hartſhorn, to make a red ſolution of flowers of ſulphur, and that with ſpirit of urine (though drawn without violence of fire) we have (as we elſewhere more particularly declare) diſſolved both in a very gentle heat, and in a very ſhort time, the unopened body of crude copper, ſo as to make thereof a ſolution of a rich, deep, and even opacous blue; and that we have done almoſt the like with unrectified ſpirit of man's blood:

HE that hath, as we have done, examined by fire (eſpecially produced by the help of a burning-glaſs) that limpid liquor, that is to be found in the lymphatick veſſels, and hath taken notice of that odd conſiſtence, ſmell, crackling, and other qualities diſcernible in it by heat:

HE that obſerves, how acid liquors loſe their acidity, by working upon ſome bodies; as when ſpirit of vinegar grows almoſt inſipid upon the coral it hath corroded; and how thoſe ſaline liquors, by working upon certain bodies, degenerate into ſalts of another nature, as we have ſometimes obſerved in oil of vitriol, working upon the fourth part of its weight of quickſilver, and how the contrariety of acid and ſulphureous ſalts makes them ſometimes diſarm, ſometimes, after ſome ebullition, precipitate each other; and ſometimes unite into a third ſubſtance, of a differing nature from either of thoſe, from whoſe coalition it reſults, as we ſee in *tartarum vitriolatum*; and, as I have obſerved, in a ſalt, I ſometimes make to emerge from a due proportion of oil of vitriol and ſpirit of urine, freed, after conjunction, from their aqueous moiſture: And he, in a word, that hath carefully analyzed and made trials on many parts, both of the macrocoſm and microcoſm, and heedfully applied his experiments made on the former to the illuſtration of the changes obſervable in the latter, ſhall be likely to explicate divers particulars in pathology more intelligibly, than he that is a ſtranger to chymiſtry.

That ſalt and ſulphur have more influence in the cauſation of diſeaſes, than the firſt qualities, as heat, cold, &c.

AND though I am very unwilling to meddle with medical controverſies, and am apt to think, that chymiſts are wont to ſpeak ſomewhat too ſlightingly of the humours of the human body, and allow them too little a ſhare in the production of diſeaſes; yet (to ſkip other reaſons) the ſtrange ſtories related by *Skenkius*, and other eminent phyſicians, of the corroſiveneſs of ſome juices, which, rejected by urine or vomits, have been able to boil on braſs, fret linen, and ſtain ſilver; together with ſome odd obſervations of this nature our ſelves have had opportunity to make, do very much incline us to believe, that the generality of former phyſicians have aſcribed too much to the humours, under the notion of their being hot and dry, cold and moiſt, or endowed with ſuch other elementary qualities, and have taken a great deal too little notice of the ſaline (if I may ſo ſpeak) and ſulphureous properties of things. And in this opinion I am not a little confirmed by the authority of *Hippocrates* himſelf, both in other paſſages, and eſpecially where he ſays, *Non calidum*, *frigidum*, *humidum*, *aut ſiccum eſſe*, *quod magnam agendi vim habet*, *verum amarum & ſalſum*, *& dulce & acidum*, *& inſipidum & acerbum*, *&c.* are the things, which, though inoffenſive to the body, whilſt they duely allay each other, prove hurtful to it, and diſtemper it, when any of them comes to ſerve it ſelf from the reſt, and grow predominant. And indeed, if the juices of the body were more chymically examined, eſpecially by a naturaliſt, that knows the ways of making fixed bodies volatile, and volatile fixed, and knows the power of the open air in promoting the former of thoſe operations; it is not improbable, that both many things relating to the nature of the humours, and to the ways of ſweetening, acuating, and otherwiſe altering them, may be detected, and the importance of ſuch diſcoveries may be diſcerned.

Obſervations made upon the liquor, that diſtends the abdomen in the dropſy.

Paracenteſis.

AND perhaps it would add to the uſefulneſs of ſuch an examination, if it were extended to the noxious juices in diſtempered bodies: ſuch as the rotten phlegm ſpit up by thoſe whoſe lungs are diſaffected; the ſlimy excretions voided in the lientery, and the liquor, that diſtends the *abdomen* in the dropſy and *aſcites:* concerning which (to tell you that upon the by) I found, that it was of a differing nature from either water or urine. For a *Paracenteſis* being made in the *abdomen* of one dangerouſly ſick of this ſort of dropſy, I found, that the liquor would keep a pretty while without putrefaction, (nor did the patient's body, when I afterwards ſaw it opened, ſmell almoſt at all, though the inſide of the *abdomen* looked well as near as black, as if it had been ſphacelated:) and having ſteamed away ſome of it, whilſt it was pretty freſh, over a ſomewhat ſlow fire, it firſt coagulated into a ſubſtance like whites of eggs, and, by a little farther evaporation, turned to ſuch a glutinous ſubſtance, as tradeſmen are wont to call ſize; and being kept longer on the fire grew to be hard like fiſh-glew, but more brittle, and tranſparent enough, but with a little tincture of a greeniſh yellow; and ſome of the fore-mentioned liquor being diſtilled in a retort, did towards the end of the operation ſo darken the veſſel with a thick blackiſh oil, as hindered me from diſcerning what elſe perhaps I might have ſeen. And I ſuppoſe it may prove a uſeful inſtance to the former purpoſe, if I ſomewhat circumſtantially annex here what occurred to me, when I was accidentally conſidering of the *calculus humanus*.

Obſervations on the calculus humanus.

HAVING therefore obtained of a ſkilful lithotomiſt of my acquaintance divers ſtones, which he had cut out of men's bladders, I choſe a couple of them (which were whitiſh almoſt, of equal bigneſs, and figure, which was near oval, and which together weighed about two ounces and an half:), theſe with the help of a ſtrong knife I carefully opened, to find whether or no either of them conſiſted of an intire and uniform matter, (as moſt other ſtones, and even ſome *calculi humani* do;) and I found, that each of them was made up of ſeveral ſhells, as it were ſucceſſively involving one another, like the rinds of an onion. And ſuch ſhells, but more ſoft, and more of a colour, we likewiſe obſerved in a great ſtone taken a while ſince out of an ox's gall, and ſent us for a preſent: and though all of theſe were of an almoſt ſtony hardneſs, yet that hardneſs was not equal in them all; and in one of the ſtones we obſerved one of the rinds (to make uſe of that expreſſion) to be of a differing colour both from that which immediately embraced it, and from that which it immediately embraced: ſome of theſe rinds equalled in thickneſs the length of a barley-corn, and others were ſomewhat thinner. Though they did cloſely embrace one another, yet they were actually ſeparable, as well as viſibly diſtinguiſhable. And proceeding very warily in the breaking one of theſe ſtones, we found, that in the center of it there lay a ſmall and ſoft oval ſtone, as it were the kernel of thoſe conglomerated ſhells; and this kernel lay ſo looſe, that with a little induſtry and patience we picked it out of the ſhell, and kept it by us as a rarity. This done, being deſirous to know, whether chymical tortures would force theſe concretes to a farther confeſſion of their nature, we cauſed them to be finely powdered, and put into a ſmall but ſtrongly coated glaſs-retort, whereunto luting a much larger retort for a receiver, we found, that theſe two ounces and half of powder, being diſtilled for ſome hours in a naked fire, afforded us great ſtore of volatile ſalt (partly grey and partly white) which almoſt covered the inſide of the receiver, and a pretty quantity of reddiſh ſpirit, which in the receiver itſelf ſoon coagulated into ſalt: and having ſevered our veſſels, we found in the neck of the receiver a very little darkiſh oil, but in the neck of the retort a greater quantity of the ſame aduſt oil, incorporated with a pretty quantity of volatitle ſalt, whoſe ſmell did really recall to my mind that peculiar kind of ſtink, which I had ſometimes taken notice of in the volatile ſalt of unfermented urine; nor were the taſtes of theſe two ſalts unlike. The *caput mortuum* conſiſted of a fine, light, coal-black powder, not unlike the fineſt ſort of ſoot; and by weighing but of ſix drachms, informed us, that above two thirds of the diſtilled *calculi humani* had been, as being volatile, forced from the terreſtrial parts, even in a cloſe veſſel, wherein the *caput mortuum*, though it were left inſipid enough, yet retained ſtink enough to make us think it ſtill contained pretty ſtore of heavy oil: as indeed, having put it into a crucible, and kept it a competent while in a ſtronger fire, we found it reduced to about two drachms of a brittle maſs of inſipid white calx, which did not ſlack, or fall aſunder like lime, when it is caſt into the water.

Of the changes, that may reaſonably be thought to happen to our aliments within the body.

To this example of the uſefulneſs of chymiſtry, to diſcover the unobſerved, and otherwiſe ſcarce diſcoverable difference of the *calculus humanus* from other ſtones, we may venture to add, that though ſome Paracelſians do take too much liberty, when they crudely tell us, that there are arſenical, vitriolate, aluminous, and other mineral ſubſtances, generated in human bodies; yet if they had more warily propoſed their doctrine, it would not perhaps appear ſo abſurd, as they are wont to think it, who conſidering only the nature of the aliments men uſually feed upon, cannot conceive,

that

that ſuch being but either animals or vegetables, can by ſo gentle a heat as that of man's body, (by which they ſuppoſe all the changes of the aliments muſt be effected) be exalted to an energy like that of ſuch bodies, as are compoſed of active mineral ſubſtances, and have ſome of them perchance acquired a violence of operation from the fire. But we ſee, that concretions, ſo like ſtones, (which belong to the mineral kingdom) as to paſs generally for ſuch, may be produced in the bodies not only of men but of ſucking children, whoſe aliment is fluid milk: and it ſeems a miſtake to imagine (how many ſoever do ſo) that heat muſt needs be efficient of all the changes the matter of our aliments may happen to undergo in a human body; where there are ſtrainers, and ſolvents, and new mixtions, and perhaps ferments, and divers other powerful agents, which by ſucceſſively working upon the aſſumed matter, may ſo faſhion and qualify it, as, in ſome caſes, to bring the more diſpoſed part of it to be not unlike even foſſile ſalts, or other mineral ſubſtances. A very eminent perſon was lately complaining to me, that in the fits of a diſtemper, which almoſt as much puzzles her phyſicians as herſelf, ſhe ſometimes vomits up ſomething ſo ſharp and fretting, that, after it hath burnt her throat in its paſſage, almoſt like ſcalding water, it doth not only ſtain the ſilver veſſels, that received it, but alſo work upon them as if it were a corroſive menſtruum. And there died a while ſince a very intelligent perſon, much imployed in publick affairs, who complained to me, that in the fits of the ſtrange diſtemper he laboured under, he divers times obſerved, that that part of his pillow, which his breath paſſed along, would by the ſtrange fuliginous ſteams, which that carried off with it, be blacked over, as if it had been held in ſome ſooty ſmoke or other.

Illuſtrated by the example of juices out of the body.

WE may alſo conſider, that the rain-water, which in its paſſage through a vine, or an apricock-tree, or the like plants is turned into a ſweet fruit; in its paſſage through thoſe plants, that bear lemons and barberries, is tranſmuted into a liquor ſharp enough to corrode, not only pearls but coral, *lapides cancrorum*, and other hard concretes, as ſpirit of vitriol would do. And writers of unſuſpected credit affirm, that an Indian fruit, (whoſe name I cannot readily call to mind) will ſpeedily corrode and waſte the very ſteel knives it is cut with, if its juice be left long upon them: and we ſee, that ſome ſorts even of our apples and pears will quickly black the blades of knives on which the juice is ſuffered to continue. And leſt what I freſhly mentioned about lemon-trees, ſhould be queſtioned, I will here add, that I remember alſo, that I have made not only ſome other hot and ſtrongly taſted herbs, but even a ranunculus it ſelf, to grow and increaſe notably in weight as well as bulk, though I fed it but with fair water; and allowed it nothing elſe to ſhoot its root into. Wherefore ſince this plant is reckoned amongſt thoſe, that either are poiſonous, or want but little of being ſo; and ſince its operation is ſo violent, that this ſort of vegetables is taken notice of from the experience of country people, to be able by outward application to draw bliſters, and ſince nevertheleſs that, which this plant, without any heat diſcernible by the touch, tranſmutes into ſo virulent a ſubſtance, is but ſo unactive a body as water; why may not ſuch aliments, as may have in them divers parts of a far more operative nature, be in a human body, by an unuſual concourſe of cauſes and circumſtances, ſo altered and exalted, as to approach in operations (eſpecially upon the more tender parts) to thoſe of foſſile ſalts or other minerals? So that a chymiſt might upon ſuch an account, without any great abſurdity, teach ſome parcels of morbifick matter to be of an arſenical, or vitriolate, or an antimonial nature, eſpecially ſince we ſee, that ſometimes cancers, ulcers, and ſharp juices generated in the body, do by their vitiating and waſting the invaded parts, but too much emulate the pernicious operations of arſenick, and of fretting ſalts: and the infuſion of antimony doth ſcarce more ſtimulate nature to diſburthen her ſelf both upwards and downwards, than doth ſometimes an humour, ſuch as that, which cauſes the *cholera morbus*, and perhaps more violent diſeaſes.

AND that ſuch degeneration of innocent aliments ſhould ſometimes happen in diſcompoſed bodies, you will perhaps think the leſs ſtrange, if you duly perpend what I lately mentioned of the tranſmutation of water into hot and veſicatory ſubſtances; and if thereto I annex, that from a ſingle pound of ſo common and temperate an aliment as bread, I can by an eaſy way, (and that without addition) obtain many ounces of a menſtruum, which (as trial has informed) will work more powerfully upon bodies more compact than ſome hard minerals, or perhaps glaſs it ſelf, than a wary chymiſt would expect to ſee aqua fortis do. Theſe things I have mentioned, *Pyrophilus*, to intimate ſome of the reaſons, why I think chymical experiments may be uſefully applied, to illuſtrate ſome things in pathology, either by imitating out of the body the productions of ſome ſorts of morbifick matter, or by ſuch reſolutions as that, which is generated in the body, as may conduce to the diſcovery of its nature. And not that I think, as Spagyriſts do, the experiments or notions of vulgar chymiſts ſufficient to explicate the whole doctrine either of digeſtion or diſeaſes; for it would be very difficult for them to make out the manner of nutrition, or ſo much as how they, that feed only on vegetables, ſhould (to propoſe the difficulty in their own terms) have their blood and urine copiouſly enriched with a volatile ſulphureous ſalt, of which ſort plants are not wont to yield any in diſtillation. And much more difficult would it be for them, by principles peculiar to chymiſts, to make out the propagation of hereditary diſeaſes: or how madneſs, and ſome other diſtempers, that do not viſibly vitiate the organs of thoſe functions that they pervert, ſhould not only prove hereditary, but lurk very many years in the inheriting perſon's body, before they begin to diſcloſe themſelves; and ſometimes too, be tranſmitted from the grandfather to the grand-child, and ſkip immediately the intervening ſon. And therefore I ſay again, that I pretend not, that vulgar chymiſtry will enable a phyſician to explicate all or moſt of the pathological phænomena; but that true chymiſtry may aſſiſt him to explicate divers of them, which can ſcarce be ſolidly explicated without it. And let me add, that he, that thoroughly underſtands the nature of ferments and fermentations, ſhall probably be much better able than he, that ignores them, to give a fair account of divers phænomena of ſeveral diſeaſes (as well fevers as others) which will perhaps be never thoroughly underſtood, without an inſight into the doctrine of fermentation; in order to which, for that and other reaſons, I deſigned my hiſtorical notes touching that ſubject.

**Difference between vulgar and true chymiſtry.**

**The uſe of the knowledge of fermentation.**

YET I am not ſure, but there may be effervescences, (and perhaps periodical ones) in the blood and other juices of the body without fermentation properly ſo called. For there may be divers other ways of begetting a preternatural heat in the blood. We often ſee, that in coughs, when the phlegm is rotten (as they ſpeak) that is, when its former viſcous texture is altered, it does no longer ſtick faſt to the veſſels of the lungs, to which it obſtinately adhered before. And ſo at certain times other humours in the body, either by growing more fluid themſelves, or by ſome change in the blood, whereby it becomes fitter to diſſolve ſuch humours, may ſwim in, and be circulated with the maſs of blood, and thereby occaſion preternatural heats; either by their indiſpoſition to be well incorporated therewith; or by altering its texture; or diſturbing the wonted motion of its minute parts; or by oppoſing its due rarefaction, as it paſſeth through the heat; or by obſtructing the more ſlender veſſels; and ſo hindering the free circulation of the blood through them; perhaps alſo cauſing ſome extravaſation, as we ſee, that wounds and bruiſes are attended with ſome inflammation, more or leſs, of the part affected; or by ſome other of the ways not now to be declared. And trial hath taught me, that there

**Of periodical effervescences in the blood without fermentation.**

there are liquors, in which the bare admixture of milk, oil, or other liquors, nay or of cold water, will preſently occaſion a notable heat: and I ſometimes employ a menſtruum, in which nothing but a little fleſh being put, though no viſible ebullition enſue, there will in a few minutes be excited a heat intenſe enough to be troubleſome to him, that holds the glaſs. And yet it ſeems not neceſſary, that this ſhould be aſcribed to a true fermentation, which may rather proceed from the perturbed motion of the corpuſcles of the menſtruum, which being by the adventitious liquor or other body put out of their wonted motion, and into an inordinate one, there is produced in the menſtruum a briſk confuſed agitation of the ſmall parts, that compoſe it; and in ſuch an agitation (from what cauſe ſoever it proceeds) the nature of heat ſeems mainly to conſiſt. But to diſpatch, I ſcarce doubt, but that if in the hiſtory of diſeaſes, there were better notice taken of thoſe phænomena, that agree not with the opinions already in requeſt, as well as of thoſe, that are thought conſonant to them; and if alſo chymical trials were ſkilfully varied, and judiciouſly applied to this illuſtrating of pathological phænomena, the former might be made conducing to the better explication of the latter: eſpecially if the buſineſs were managed by a naturaliſt well verſed both in chymical experiments, and in anatomy, and the hiſtory of diſeaſes, without being too much addicted either to the chymiſts notions, or the received opinions of phyſicians.

Of the uſe of zoology to the knowledge of diſeaſes.

AND as the naturaliſt may thus illuſtrate pathology as a chymiſt, ſo may he do the like as a zoologer; for either the true knowledge of anatomy muſt be much leſs uſeful to phyſicians than they have hitherto believed, or elſe the diſcoveries made by recent anatomiſts of the Aſellian, Pecquetian, and Bartholinian veſſels, by either overthrowing the received doctrine of digeſtions, (from whoſe aberrations many diſeaſes ſpring) or at leaſt by making divers diſcoveries in relation to the oeconomy of digeſtions unknown to the ancients, muſt probably contribute much to the clearing up of divers pathological difficulties in the explication of ſome diſeaſes; beſides that the very liberty of making thoſe experiments in live beaſts, which are not to be made but in living creatures, nor are allowable to be made in living men, may enable a zoologiſt, by giving us a clearer account of divers parts of the body, to determine divers pathological difficulties ſpringing from either our ignorance or miſtakes of the uſe of thoſe parts, as by the formerly mentioned experiment of the exſection of a live dog's ſpleen, and a watchful obſervation of all the diſeaſes upon that account, befalling him and other dogs ſo ſerved; much light perhaps may be given to the doctrine of the uſe of the ſpleen, together with the diſeaſes ſuppoſed to depend upon that part, which I fear is hitherto (to the no ſmall prejudice of the ſick) by few phyſicians throughly underſtood, and by many unhappily enough miſtaken.

AND here we may repreſent unto you, *Pyrophilus*, that not only the diſſections of ſound beaſts may aſſiſt the phyſician to diſcover the like parts of a human body, but the diſſections of morbid beaſts may ſometimes illuſtrate the doctrine of the cauſes and ſeats of diſeaſes. For that this part of pathology has been very much improved by the diligence of modern phyſicians, by diſſecting the bodies of men killed by diſeaſes, we might be juſtly accuſed of want of curioſity, or gratitude, if we did not thankfully acknowledge; for indeed much of that improvement of phyſick, (for which the antients, were they now alive, might envy our new phyſicians) may, in my poor opinion, be aſcribed to their induſtrious ſcrutiny of the ſeat and effects of the peccant matter of diſeaſes in the bodies of thoſe that have been deſtroyed by them.

AND that the inſtructions deducible from ſuch obſervations may be either increaſed or illuſtrated by the like obſervations made in the bodies of beaſts, we have been inclined to think, partly by the having chymically analyzed (as they phraſe it) the blood of divers brutes, as ſheep, deer, *&c.* and found its phlegm, ſpirit, ſalt, and oil, very like that of human blood; and partly, by our having obſerved in the bodies of ſeveral brutes, (not excepting fiſhes) worms, impoſthumes, and the like, ſome of which ſeemed manifeſtly to ſpring from ſuch cauſes, as are wont to produce reſembling diſtempers in men. And if the acute *Helmont* had been a more diligent diſſector of beaſts, he would perchance have eſcaped the error he after others run into (and into which his authority hath tempted others to run) when he affirmed, that the ſtone was a diſeaſe peculiar to men; for that in the bodies of beaſts, eſpecially very old ones, ſtones are ſometimes to be found, not only ſeveral butchers have aſſured me, but you may gather partly from that taken out of an ox's gall, which I have formerly mentioned, which was about the bigneſs of a walnut, but principally from what I elſewhere delivered on purpoſe to diſprove that fond aſſertion. And greater leiſure may, upon another occaſion, invite us to mention ſome pathological obſervations made in diſeaſed beaſts, by which (were we not willing to haſten) we might now perhaps much confirm what we have propoſed touching the poſſibility of illuſtrating, by ſuch obſervations, the nature of ſome of the diſeaſes incident to human bodies.

*Helmont*'s error refuted, that the ſtone is a diſeaſe peculiar to man.

AND here we may alſo conſider, that there are divers explications of particular diſeaſes, or troubleſome accidents propoſed by phyſicians, eſpecially ſince the diſcovery of the blood's circulation, wherein the compreſſion, obſtruction, or irritation of ſome nerve, or the diſtenſion of ſome vein by too much blood, or ſome hindrance of the free paſſage of the blood through this or that particular veſſel, is aſſigned for the cauſe of this or that diſeaſe or ſymptom. Now in divers of theſe caſes the liberty lately mentioned, that a ſkilful diſſector may take in beaſts, to open the body or limbs, to make ligatures ſtrong or weak on the veſſels, or other inward parts, as occaſion ſhall require, to leave them there as long as he pleaſeth, to prick, or apply ſharp liquors to any nervous or membranous part, and whenever he thinks convenient, to diſſect the animal again, to obſerve what change his experiment hath produced there: ſuch a liberty, I ſay, which is not to be taken in human bodies, may in ſome caſe either confirm or confute the theories propoſed, and ſo put an end to divers pathological controverſies, and perhaps too occaſion the diſcovery of the true genuine cauſes of the phænomena diſputed of, or of others really as abſtruſe.

To this let me add, that there is a whole claſſis of diſeaſes to be met with in phyſicians books, which proceed not originally from any internal diſtemper of the patient, but are produced by ſome exteriour poiſon, and are therefore wont to be called by doctors, *morbi à veneno orti*, to the more accurate knowledge of divers of which diſeaſes experiments made on brutes may not a little conduce. For though I deny not, that ſome things may be poiſonous to man, that are not ſo to ſome beaſts; and on the contrary (as we have more than once given to a dog, without much harming him, ſuch a quantity of opium, as would probably have ſufficed to have killed ſeveral men) yet the greater number of poiſons being ſuch both to man and brutes, the liberty of exhibiting them, when, and in what manner we pleaſe, to theſe (which we dare not do to him) allows us great opportunities of obſerving their manner of operation and inveſtigating their nature, as ourſelves have tried, and that ſometimes with unexpected events (as when lately a cat ran mad, ſo that her keeper was fain to kill her) upon a large doſe of opium which we cauſed to be given her.

AND on this occaſion I ſhall not ſcruple to tranſcribe one obſervation out of a diſcourſe, I ſome years ſince writ to a friend, about the turning poiſons into medicines, becauſe that treatiſe I am like, for certain reaſons, to ſuppreſs: the words, as I there find them, are theſe.

‘ BEFORE I take leave of vipers (or adders, as ſome will have thoſe, that here in
‘ *England* commonly paſs for vipers) it will not be impertinent to tell you, that it may

‘ be

That the venom of vipers or adders conſiſts chiefly in the rage and fury, wherewith they bite, and not in any part of the body that hath at all times a mortal property.

‘ be juſtly doubted; whether they be to be reckoned amongſt poiſonous creatures, in ſuch a ſenſe as thoſe other venomous creatures, who have in them a conſtant, and, if I may ſo ſpeak, groſs and tangible poiſon; for it may be ſuppoſed, that the venom of vipers conſiſts chiefly in the rage and fury, wherewith they bite, and not in any part of the body, which hath at all times a mortal property: thus the madneſs of a dog makes his teeth poiſonous, which before were not ſo. And authors of good repute ſupply us with inſtances of hurts, in themſelves free from danger, that have been made fatal by a venom created by the fierceneſs of the enraged (though not otherwiſe poiſonous) creatures that inflicted them. And *Baccius*, if I miſtake not, in his treatiſe *de venenis*, tells us a memorable ſtory (whereof he affirms himſelf to have been an eye-witneſs) of a man, who was killed within three days, by a ſlight hurt received in his left hand, from an enraged dunghill-cock; and that no parts of the viper have any conſtant inherent poiſon in them, I have been induced to ſuſpect upon this experiment, that diſſecting ſome live vipers, there came in accidentally a ſtrange dog, to whom I gave the head, tail, and gall, (which are the parts ſuppoſed to contain the poiſon) of one of them, and the head and gall of another, wrapt up in meat; after which I locked the little dog up in my own chamber, and watched him; but found not that he was ſick, or offered to vomit at all, but only lapped up greedily ſome drink, which he eſpied in the room: nor was he alone very jocund, for divers hours that I kept him in, but liked his entertainment ſo well, that he would afterwards, when he met me in the ſtreet, leave thoſe, that kept him, to fawn on and follow me. And having ſince related this experiment to an inquiſitive friend of mine, he aſſured me, that to ſatisfy himſelf further in this particular, he gave to a dog a dozen heads and galls of vipers, without finding them to produce in him any miſchievous ſymptom. To which I ſhall add, that the old man you know, that makes viper-wine, does it (as himſelf tells me) by leaving the whole vipers, if they be not very great, perhaps for ſome months, without taking out the galls, or ſeparating any other part from them in the wine, till it hath diſſolved as much of it as it can.

A certain cure for the biting of vipers.

‘ AND though it may ſeem ſomewhat improper, whilſt we are diſcourſing of poiſons, to inſiſt on a remedy againſt them; yet the mention of vipers recalling into my mind a memorable experiment, which I tried againſt the biting of vipers, I ſhall chuſe rather to decline the dictates of method, than thoſe of charity, which forbids me to ſuppreſs a remedy, that may poſſibly reſcue from ſudden death a perſon or other fit to live, or unprepared to die; becauſe it does not ſtrictly belong to the theme, whereto it is referred. The remedy then is this, that as ſoon as ever a man is bitten, (for if the poiſon have had time enough to diffuſe it ſelf, and gain the maſs of blood, I doubt the experiment will ſcarce ſucceed) a hot iron be held as near the place, as the patient can poſſibly endure, till it have, as they ſpeak, drawn out all the venom: which eye-witneſſes aſſure me (for I have not yet ſeen that my ſelf) will ſometimes adhere like a yellowiſh ſpot to the ſurface of the iron. But being upon competent grounds ſatisfied of the experiment, to convince a phyſician, that miſtruſted it; I laſt ſummer hired a man (who doubted it as little as I) to ſuffer himſelf to be bitten by a viper; and having in the phyſician's houſe and preſence picked out of a good number of them, one of the blackeſt I could find (thoſe of that colour being ſuppoſed the moſt miſchievous) and commanded the fellow to provoke and anger it, (which to my wonder he did, a pretty while before the beaſt would faſten on him;) at length being by his very rude handling thoroughly exaſperated, it bit him with great fury, as it ſeemed: for immediately his hand began to ſwell, and the injured part was grown tumid, before we could take from the fire, which was hard by, a

‘ knife, that lay heating there; and having applied it as near as he could ſuffer it, for about ten or twelve minutes, we found, that the ſwelling, though it decreaſed not, did not ſpread, and the man glad of his money, without farther ceremony, went about his affairs, and told me ſince, that though the tumour continued a while, he had no other inconvenience attending it, and hath divers times got money by repeating the experiment; though otherwiſe, by the caſual bitings of vipers, he hath been much diſtreſt, and his wife almoſt killed.’

BUT, *Pyrophilus*, to return to the experiments of poiſons made on beaſts, we could wiſh phyſicians were more diligent to make trials of them, not only by giving beaſts poiſons at the mouth, but alſo by making external applications of them, eſpecially in thoſe parts, where the veſſels, that convey blood, more approach the ſurface of the body, and alſo by dexterouſly wounding determinate veins with inſtruments dipt in poiſons (eſpecially moiſt or liquid ones) that being carried by the circulated blood to the heart and heat, it may be found, whether their ſtrength be that way more uninfringed, and their operation more ſpeedy (or otherwiſe differing) than if they were taken in at the mouth. For I remember ſober travellers have ſhewed me ſome Indian poiſons, whoſe noxious efficacy they affirmed to be, by great intervals of time, differingly mortal, according as the ſlight hurt made by the points of arrows, infected with them, did open a capillary or larger vein, and were inflicted on a part more or leſs diſtant from the heart; but having not yet made any trial of this my ſelf, I dare not build upon it. Yet I find, that the formerly commended *Olearius*, in his travels into *Muſcovy* and *Perſia*, takes notice of a venomous inſect in *Perſia*, which the natives call *Encureck*, and which he (how juſtly I know not) makes to be a kind of *Tarantula*, becauſe it is, as that creature, in ſhape almoſt like a ſpider, and ſpeckled, though of twice the bigneſs of a thumb: this inſect (ſays he) inſtead of ſtinging or biting, lets his venom fall in form of a drop of water, which immediately produces inſufferable pains in the part to which it faſtens; and ſuddenly penetrating as far as to the ſtomach, ſends up vapours to the head, which ſends again (to uſe his expreſſion) ſo profound a ſleep to all the patient's limbs, that it is impoſſible to awaken him, but by one only remedy, which is to cruſh one of theſe creatures upon the hurt, whence he abſtracts all the poiſon. Some horrid and unuſual ſymptoms of this venom, which yet agree not ſo well with thoſe, that are wont to be produced in perſons bitten by *Tarantula's*, our author proceeds to mention; and furniſhes us with a proof of what we were lately ſaying, when we told you, that ſome things were poiſonous to men, which were not to ſome beaſts; by adding, as an admirable ſingularity, that the ſheep of thoſe parts do not only eat theſe fatal inſects, but ſeek for them. I know alſo, by ſad experience in my ſelf, what an outward application even of cantharides can do; for having occaſion to have a large bliſter drawn on my neck, the chirurgeon I employed, unknown to me, made uſe of cantharides, among other ingredients of his veſicating plaiſter, which, a few hours after I had taken it, wakened me with exceſſive torment, to which it put me about the neck of my bladder, ſo that I apprehended it might proceed from ſome ſtone unable to get out; of which ſudden and ſenſible pain, after I had a while in vain conjectured, what might be the cauſe, I at length ſuſpected that, which was indeed the true one; and having ſent for the chirurgeon, he confeſſed to me, upon my demand, that he had put ſome cantharides in his plaiſter, not thinking it would have had ſuch an operation: whereupon I ſoon relieved my ſelf, by drinking new milk very well ſweetened with ſugar candy.

Of external application of poiſons, and letting them into the veins of beaſts.

Voyage de Muſcovie & de Perſe, p. 334.

# POSTSCRIPT.

**Experiments of conveying liquid poiſons immediately into the maſs of blood.**

TO enable you, *Pyrophilus*, to gratify thoſe inquiſitive perſons, that have heard ſome, and yet but an imperfect report, of a much noiſed experiment, that was ſome years ago deviſed at *Oxford*, and ſince tried in other places before very illuſtrious ſpectators; I am content to take the occaſion afforded me, by what was in the foregoing eſſay lately mentioned concerning the application of poiſons, to inform you, that a pretty while after the writing of that eſſay, I happened to have ſome diſcourſe about matters of the like nature, with thoſe excellent mathematicians, Dr. *J. Wilkins*, and Mr. *Chriſtopher Wren*; at which the latter of thoſe virtuoſi told us, that he thought he could eaſily contrive a way to convey any liquid poiſon immediately into the maſs of blood. Whereupon our knowledge of his extraordinary ſagacity making us very deſirous to try what he propoſed, I provided a large dog, on which he made his experiment in the preſence, and with the aſſiſtance of ſome eminent phyſicians, and other learned men. His way (which is much better learned by ſight than relation) was briefly this: firſt, to make a ſmall and opportune inciſion over that part of the hind leg, where the larger veſſels that carry the blood, are moſt eaſy to be taken hold of: then to make a ligature upon thoſe veſſels, and to apply a certain ſmall plate of braſs (of above half an inch long, and about a quarter of an inch broad, whoſe ſides were bending inwards) almoſt of the ſhape and bigneſs of the nail of a man's thumb, but ſomewhat longer. This plate had four little holes in the ſides, near the corners, that, by threads paſſed through them, it might be well faſtened to the veſſel. And in the ſame little plate there was alſo left an aperture, or ſomewhat large ſlit, parallel to the ſides of it, and almoſt as long as the plate, that the vein might be there expoſed to the lancet, and kept from ſtarting aſide. This plate being well faſtened on, he made a ſlit along the vein, from the ligature towards the heart, great enough to put in at it the ſlender pipe of a ſyringe, by which I had propoſed to have injected a warm ſolution of opium in ſack, that the effect of our experiment might be the more quick and manifeſt. And accordingly our dextrous experimenter having ſurmounted the difficulties, which the tortured dog's violent ſtrugglings interpoſed, conveyed a ſmall doſe of the ſolution or tincture into the opened veſſel, whereby, getting into the maſs of blood (ſome quantity of which, it is hard to avoid ſhedding in the operation) it was quickly, by the circular motion of that, carried to the brain, and other parts of the body. So that we had ſcarce untied the dog (whoſe four feet it had been requiſite to faſten very ſtrongly to the four corners of the table) before the opium began to diſcloſe its narcotick quality; and almoſt as ſoon as he was upon his feet, he began to nod with his head, and faulter and reel in his pace, and preſently after appeared ſo ſtupified, that there were wagers offered his life could not be ſaved. But I, that was willing to reſerve him for further obſervation, cauſed him to be whipped up and down a neighbouring garden, whereby being kept awake and in motion, after ſome time he began to come to himſelf again, and being led home, and carefully tended, he not only recovered, but began to grow fat ſo manifeſtly, that it was admired: but I could not long obſerve, how it fared with him; for this experiment, and ſome other trials I made upon him, having made him famous, he was ſoon after ſtolen away from me. Succeeding attempts informed us, that the plate was not neceſſary, if the finger were ſkilfully employed to ſupport the veſſel to be opened; and that a ſlender quill, faſtened to a bladder, containing the matter to be injected, was ſomewhat more convenient than a ſyringe; as alſo, that this notwithſtanding, unleſs the dog were pretty big, and lean, that the veſſels might be large enough and eaſily acceſſible, the experiment would not eaſily ſucceed. The inventor of it afterwards practiſed it in the preſence of that moſt learned noble man, the Marquis of *Dorcheſter*, and found, that a moderate doſe of the infuſion of *crocus metallorum* did not much move the dog, to whom it was given: but once that he injected a large doſe (about two ounces or more) it wrought ſo ſoon, and ſo violently upon a freſh one, that within a few hours after, he vomited up life and all, upon the ſtraw, whereon they had laid him. I afterwards wiſhed, that not only ſome vehemently working drugs, but their appropriated antidotes, (or elſe powerful liquid cordials) and alſo ſome altering medicines, might be in a plentiful doſe injected. And in diureticks a very ingenious anatomiſt and phyſician told me, he tried it with very good ſucceſs. I likewiſe propoſed, that if it could be done, without either too much danger or cruelty, trial might be made upon ſome human bodies, eſpecially thoſe of malefactors. And ſome months after, a foreign ambaſſador, a curious perſon, at that time reſiding in *London*, did me the honour to viſit me, and informed me, that he had cauſed trial to be made with infuſion of *crocus metallorum*, upon an inferiour domeſtick of his, that deſerved to have been hanged; but that the fellow, as ſoon as ever the injection began to be made, did (either really or craftily) fall into a ſwoon, whereby being unwilling to proſecute ſo hazardous an experiment, they deſiſted; without ſeeing any other effect of it, ſave, that it was told the ambaſſador, that it wrought once downward with him, which yet might, perhaps, be occaſioned for fear or anguiſh. But the trials of a very dextrous phyſician of my acquaintance, in human bodies, will perhaps, when I ſhall have received a more circumſtantial account of them, be not unwelcome to you. And in dogs, you may poſſibly, from our own obſervations, receive a further account of an experiment; of which, I now chiefly deſigned but to relate to you the riſe and firſt attempts.

# ESSAY III.

## *Containing ſome particulars relating to the Semeiotical part of Phyſick.*

THE ſemeiotical part of the phyſician's art ſeems capable of the leaſt improvement by natural philoſophy. In which yet, firſt the naturaliſt may, by illuſtrating the anatomical and pathological parts, aſſiſt the phyſician to make more certain conjectures from the ſigns he diſcovers of the conſtitution and diſtempers of his patient. For you will eaſily believe, that, *cæteris paribus*, he, that better knows the nature of the parts and juices of the body, will be better able to conjecture at the events of diſeaſes, than he that is leſs ſkilled in them. And ſecondly, the naturaliſt by improving the therapeutical, may at leaſt much change and alter the prognoſticks of the duration, ferocity, and event of diſeaſes. For, *Pyrophilus*, it would be conſidered, that the predictions hitherto current in authors, and commonly made by phyſicians, ſuppoſe the uſe of the received remedies, and the dogmatical method of phyſick; but if there were diſcovered ſuch generous and commanding medicines, as, by powerfully aſſiſting nature, or nimbly proſcribing the morbifick matter, that doth either produce, or (though produced by them) cheriſh ſickneſſes, might enable nature to hinder the diſeaſe from continuing its courſe, and acting almoſt all the ſcenes of its tragedy in the body; phyſicians need

That the improvement of the therapeutical would alter the prognoſticks in the ſemeiotical part of phyſick.

not, in acute diſeaſes, wait ſo often for a criſis to inſtruct their prognoſticks; and the threatening ſymptoms of chronical diſtempers would often prove falſe prophets.

An inſtance to that purpoſe in the Peruvian bark.

To illuſtrate this but with a not ignoble inſtance, give me leave to tell you, that when that Peruvian bark, that now begins to be ſomewhat taken notice of, under the name of the Jeſuits powder, had ſcarce been ſo much as heard of in this part of *Europe*, I went to viſit a virtuoſo, who had been for ſome months afflicted with a quartan ague, ſo violent and ſtubborn, that it had fruſtrated the ſkill, and almoſt tired the endeavours of the moſt eminent doctors of this nation; of one of which, who was then accidentally with his learned patient, I inquired how my friend did, and was anſwered, that he hoped he would recover, when the ſeaſon would give him leave; but in the winter he knew no quartans cured. Yet the gentleman acquainting me with his having procured ſome of the American bark againſt agues, which we mentioned in a former eſſay, and I (after having taſted and conſidered it) having encouraged him, as I have others, to make trial of it, as the ſtrange effects I have obſerved of it have divers times invited me to do; the candid and learned doctor not only oppoſed not my perſuaſions, but added his own to them. And my friend taking two doſes of this powdered bark, though it were at the unhopeful ſeaſon of the year (the winter ſolſtice) and though he ſcarce found any ſenſible operation (unleſs a little by ſweat) of the Peruvian medicine, had by the firſt doſe his fit very much leſſened, and by the ſecond quite removed. And though through ſome irregularities of diet (to which that keen appetite, like that of recovering perſons, which I have obſerved this powder to be wont to produce, tempted him) he did, as I then foretold him he would, after miſſing eight or ten fits, relapſe; yet by the repeated uſe of the ſame remedy, he again recovered, and hath continued ſo ever ſince. Having alſo lately perſuaded the uſe of the ſame medicine, in the ſame diſeaſe, to one of the greateſt ladies in this nation, ſhe told me the other day, that it immediately, and in unlikely weather, freed her from thoſe fits, from whence ſhe deſpaired to be delivered till the ſpring. Having likewiſe ſent ſome of it to a couple of gentlemen, ſick of the like malady, I had word brought me, that one had miſſed his fits for a month, though in the midſt of winter; and the other was by the firſt doſe cured, and continues ſo. And divers eminent phyſicians, to whom I have commended the ſpecifick, have uſed it with ſuch ſucceſs, that one of the ſevereſt of them, though he had formerly deſpiſed it, confeſſed to me, that in a ſhort time he tried it upon eight or nine ſeveral perſons, without finding it to fail in any, though one of them eſpecially were, before he was called, judged irrecoverable; the obſtinate quartan being complicated with other almoſt as dangerous diſtempers. And I confeſs I ſomewhat wonder, that men have not the curioſity to try the efficacy of this powerful bark in other diſeaſes than agues; it being highly probable, that a medicine, capable to prevail ſo ſtrongly againſt ſo obſtinate a diſeaſe as a quartan, (wherein moſt commonly divers of the conſiderable parts of the body are much affected) cannot be uſeleſs to ſeveral other diſtempers. I deny not, that thoſe, that have taken this powder, have divers of them, after having miſſed ſix or ſeven fits, relapſed into them, (as it likewiſe happened to one of the gentlemen I ſent it to) yet (as I have elſewhere told you) it is much, and more than any common remedy does, to ſtop the fit ſo long. Nor is it a ſmall matter to be able to give the patient ſo much breathing time, and allow the phyſician the opportunity of imploying other remedies. And the relapſes we ſpeak of, are commonly cured by the ſame powder; and we have known them prevented, when the medicine hath been adminiſtred, not by unſkilful perſons, but by a prudent phyſician, who knows how to aſſiſt it, by opening and gently purging phyſick. Wherefore that, which I ſhould be moſt gladly ſatisfied of about this remedy, is, whether or no it do indeed, either proſcribe the morbifick matter, or ſo alter its texture as to make it harmleſs; or elſe, whether it doth ſecretly leave ſuch noxious impreſſions upon the ſpleen, guts, or ſome other important part, as may ſhorten life, by producing in proceſs of time, either the ſcurvy, or the dropſy, or ſome other formidable diſeaſe. But becauſe the reſolution of this doubt muſt be a work of time, we muſt at preſent refer it to future obſervation: and therefore ſhall now ſubjoin, that if the famous *Riverius* have not, in his learned obſervations, flattered his own *febrifugum*, whatever he reſolved touching this Indian bark, there will not want a ſafe remedy, which may allow phyſicians to make more chearful predictions about the laſtingneſs and event of quartans, than have hitherto been uſual.

And in *Riverius*'s Febrifugum, and a new cure of the King's-evil. *Riverius* in obſervat.

How painful and ſtubborn a diſeaſe the King's-evil is wont to prove, is ſcarce more known, than that it is ſeldom cured without a tedious courſe of phyſick: and yet by the herb mentioned in one of the former eſſays, the young gentleman there ſpoken of was cured in a ſhort time, and with little or no pain or trouble. And that theſe are not the only diſeaſes, in which obſervations, tending to our preſent purpoſe, may be made, the following part of this treatiſe will afford you opportunity to obſerve.

Vide infra, c. 9.

I MIGHT add, *Pyrophilus*, that I was lately viſited by an ancient chymiſt, ennobled by divers eminent cures, who promiſeth to me an experiment of making very unuſual, and yet rational predictions in ſome abſtruſe diſeaſes, by a peculiar way of examining the patient's urine. But becauſe ſome chymiſts have written extravagantly enough upon a like ſubject, and becauſe I have not yet made or ſeen the experiment of it my ſelf, I dare not yet give this new method of foretelling, for an inſtance of the uſefulneſs of natural philoſophy to the ſemeiotical part of phyſick. Though I dare not deny but by precipitations, and ſome other ways, not yet vulgarly practiſed, of examining the urine, made by the ſame patient at ſeveral times, before, in, and after ſome notable alteration in his body, divers things (eſpecially in fevers, and other acute diſeaſes) relating to the ſtate of it, may be diſcovered, eſpecially if thereto be added a ſkilful and ſeaſonable chymical examen of the other excrements, and vitiated ſubſtances of the patient's body.

YOU will perchance expect, *Pyrophilus*, that on this occaſion I ſhould handle that controverſy, which is ſo hotly agitated betwixt the Paracelſians and their adverſaries, concerning the curableneſs of all diſeaſes: but, for aught I can perceive, the difference betwixt the more ſober men of both parties is more about words than things, and might be reduced to a much leſs diſtance, if men could but calmly conſider, that it is one thing to diſpute, whether all diſeaſes be curable, and another, whether all perſons be recoverable? For a diſeaſe may be called incurable, either in its own nature, or by accident; that is, either becauſe ſuch a diſeaſe is not be cured in any patient, or that it is ſo circumſtantiated in this or that patient, as not to be naturally curable in him. Now this diſtinctly and duly conſidered may conduce much to reconcile the two opinions, if not the parties that maintain them; for neither would a ſober Paracelſian affirm, (though *Paracelſus* himſelf doth ſomewhere ſeem to do ſo) that every diſeaſe is curable in every patient, there being ſome palſies, gouts, or blindneſſes, or the like, ſo obſtinate, that (eſpecially if they are born with a man, or inherited from his parents) the tone of ſome neceſſary or conſiderable part of the body being thereby rather aboliſhed, than barely vitiated, it were a folly to promiſe recovery to ſuch a patient. And on the other ſide, a moderate Galeniſt, that is not unacquainted with the diſcoveries, which theſe latter ages have made of the power of nature and art, will not be forward to pronounce (as others do, and as the Paracelſians tax the Galeniſts too indiſcriminately for doing) that the gout, (for inſtance) the dropſy, the dead palſy, and the ſtone, are diſeaſes univerſally incurable; ſince in the writings of *Eraſtus*, and in the obſervations of *Schenckius*, and others, there are inſtances recorded of ſome cures performed of the dropſy, and one or two more of thoſe ſtubborn diſeaſes, even by Galenical remedies.

That though no diſeaſe ſhould be incurable, yet every diſeaſe is not curable in every patient.

not, in acute diſeaſes, wait ſo often for a criſis to inſtruct their prognoſticks; and the threatening ſymptoms of chronical diſtempers would often prove falſe prophets.

An inſtance to that purpoſe in the Peruvian bark.

To illuſtrate this but with a not ignoble inſtance, give me leave to tell you, that when that Peruvian bark, that now begins to be ſomewhat taken notice of, under the name of the Jeſuits powder, had ſcarce been ſo much as heard of in this part of *Europe*, I went to viſit a virtuoſo, who had been for ſome months afflicted with a quartan ague, ſo violent and ſtubborn, that it had fruſtrated the ſkill, and almoſt tired the endeavours of the moſt eminent doctors of this nation; of one of which, who was then accidentally with his learned patient, I inquired how my friend did, and was anſwered, that he hoped he would recover, when the ſeaſon would give him leave; but in the winter he knew no quartans cured. Yet the gentleman acquainting me with his having procured ſome of the American bark againſt agues, which we mentioned in a former eſſay, and I (after having taſted and conſidered it) having encouraged him, as I have others, to make trial of it, as the ſtrange effects I have obſerved of it have divers times invited me to do; the candid and learned doctor not only oppoſed not my perſuaſions, but added his own to them. And my friend taking two doſes of this powdered bark, though it were at the unhopeful ſeaſon of the year (the winter ſolſtice) and though he ſcarce found any ſenſible operation (unleſs a little by ſweat) of the Peruvian medicine, had by the firſt doſe his fit very much leſſened, and by the ſecond quite removed. And though through ſome irregularities of diet (to which that keen appetite, like that of recovering perſons, which I have obſerved this powder to be wont to produce, tempted him) he did, as I then foretold him he would, after miſſing eight or ten fits, relapſe; yet by the repeated uſe of the ſame remedy, he again recovered, and hath continued ſo ever ſince. Having alſo lately perſuaded the uſe of the ſame medicine, in the ſame diſeaſe, to one of the greateſt ladies in this nation, ſhe told me the other day, that it immediately, and in unlikely weather, freed her from thoſe fits, from whence ſhe deſpaired to be delivered till the ſpring. Having likewiſe ſent ſome of it to a couple of gentlemen, ſick of the like malady, I had word brought me, that one had miſſed his fits for a month, though in the midſt of winter; and the other was by the firſt doſe cured, and continues ſo. And divers eminent phyſicians, to whom I have commended the ſpecifick, have uſed it with ſuch ſucceſs, that one of the ſevereſt of them, though he had formerly deſpiſed it, confeſſed to me, that in a ſhort time he tried it upon eight or nine ſeveral perſons, without finding it to fail in any, though one of them eſpecially were, before he was called, judged irrecoverable; the obſtinate quartan being complicated with other almoſt as dangerous diſtempers. And I confeſs I ſomewhat wonder, that men have not the curioſity to try the efficacy of this powerful bark in other diſeaſes than agues; it being highly probable, that a medicine, capable to prevail ſo ſtrongly againſt ſo obſtinate a diſeaſe as a quartan, (wherein moſt commonly divers of the conſiderable parts of the body are much affected) cannot be uſeleſs to ſeveral other diſtempers. I deny not, that thoſe, that have taken this powder, have divers of them, after having miſſed ſix or ſeven fits, relapſed into them, (as it likewiſe happened to one of the gentlemen I ſent it to) yet (as I have elſewhere told you) it is much, and more than any common remedy does, to ſtop the fit ſo long. Nor is it a ſmall matter to be able to give the patient ſo much breathing time, and allow the phyſician the opportunity of imploying other remedies. And the relapſes we ſpeak of, are commonly cured by the ſame powder; and we have known them prevented, when the medicine hath been adminiſtred, not by unſkilful perſons, but by a prudent phyſician, who knows how to aſſiſt it, by opening and gently purging phyſick. Wherefore that, which I ſhould be moſt gladly ſatisfied of about this remedy, is, whether or no it do indeed, either proſcribe the morbifick matter, or ſo alter its texture as to make it harmleſs; or elſe, whether it doth ſecretly leave ſuch noxious impreſſions upon the ſpleen, guts, or ſome other important part, as may ſhorten life, by producing in proceſs of time, either the ſcurvy, or the dropſy, or ſome other formidable diſeaſe. But becauſe the reſolution of this doubt muſt be a work of time, we muſt at preſent refer it to future obſervation: and therefore ſhall now ſubjoin, that if the famous *Riverius* have not, in his learned obſervations, flattered his own *febrifugum*, whatever he reſolved touching this Indian bark, there will not want a ſafe remedy, which may allow phyſicians to make more chearful predictions about the laſtingneſs and event of quartans, than have hitherto been uſual.

And in *Riverius*'s Febrifugum, and a new cure of the King's-evil. *Riverius* in obſervat.

How painful and ſtubborn a diſeaſe the King's-evil is wont to prove, is ſcarce more known, than that it is ſeldom cured without a tedious courſe of phyſick: and yet by the herb mentioned in one of the former eſſays, the young gentleman there ſpoken of was cured in a ſhort time, and with little or no pain or trouble. And that theſe are not the only diſeaſes, in which obſervations, tending to our preſent purpoſe, may be made, the following part of this treatiſe will afford you opportunity to obſerve.

Vide infra, c. 9.

I MIGHT add, *Pyrophilus*, that I was lately viſited by an ancient chymiſt, ennobled by divers eminent cures, who promiſeth to me an experiment of making very unuſual, and yet rational predictions in ſome abſtruſe diſeaſes, by a peculiar way of examining the patient's urine. But becauſe ſome chymiſts have written extravagantly enough upon a like ſubject, and becauſe I have not yet made or ſeen the experiment of it my ſelf, I dare not yet give this new method of foretelling, for an inſtance of the uſefulneſs of natural philoſophy to the ſemeiotical part of phyſick. Though I dare not deny but by precipitations, and ſome other ways, not yet vulgarly practiſed, of examining the urine, made by the ſame patient at ſeveral times, before, in, and after ſome notable alteration in his body, divers things (eſpecially in fevers, and other acute diſeaſes) relating to the ſtate of it, may be diſcovered, eſpecially if thereto be added a ſkilful and ſeaſonable chymical examen of the other excrements, and vitiated ſubſtances of the patient's body.

You will perchance expect, *Pyrophilus*, that on this occaſion I ſhould handle that controverſy, which is ſo hotly agitated betwixt the Paracelſians and their adverſaries, concerning the curableneſs of all diſeaſes: but, for aught I can perceive, the difference betwixt the more ſober men of both parties is more about words than things, and might be reduced to a much leſs diſtance, if men could but calmly conſider, that it is one thing to diſpute, whether all diſeaſes be curable, and another, whether all perſons be recoverable? For a diſeaſe may be called incurable, either in its own nature, or by accident; that is, either becauſe ſuch a diſeaſe is not be cured in any patient, or that it is ſo circumſtantiated in this or that patient, as not to be naturally curable in him. Now this diſtinctly and duly conſidered may conduce much to reconcile the two opinions, if not the parties that maintain them; for neither would a ſober Paracelſian affirm, (though *Paracelſus* himſelf doth ſomewhere ſeem to do ſo) that every diſeaſe is curable in every patient, there being ſome palſies, gouts, or blindneſſes, or the like, ſo obſtinate, that (eſpecially if they are born with a man, or inherited from his parents) the tone of ſome neceſſary or conſiderable part of the body being thereby rather aboliſhed, than barely vitiated, it were a folly to promiſe recovery to ſuch a patient. And on the other ſide, a moderate Galeniſt, that is not unacquainted with the diſcoveries, which theſe latter ages have made of the power of nature and art, will not be forward to pronounce (as others do, and as the Paracelſians tax the Galeniſts too indiſcriminately for doing) that the gout, (for inſtance) the dropſy, the dead palſy, and the ſtone, are diſeaſes univerſally incurable; ſince in the writings of *Eraſtus*, and in the obſervations of *Schenckius*, and others, there are inſtances recorded of ſome cures performed of the dropſy, and one or two more of thoſe ſtubborn diſeaſes, even by Galenical remedies.

That though no diſeaſe ſhould be incurable, yet every diſeaſe is not curable in every patient.

That the hope of doing greater cures than ordinary hath engaged artiſts to make profitable trials.

But, *Pyrophilus*, though we cannot but diſapprove the vain-glorious boaſts of *Paracelſus* himſelf, and ſome of his followers, who, for all that, lived no longer than other men; yet I think mankind owes ſomething to the chymiſts, for having put ſome men in hope of doing greater cures than have been formerly aſpired to, or even thought poſſible, and thereby engage them to make trials and attempts in order thereunto. For not only before men were awakened and excited by the many promiſes and ſome great cures of *Arnoldus de Villanova*, *Paracelſus*, *Rulandus*, *Severinus*, and *Helmont*, many phyſicians were wont to be too forward to pronounce men, troubled with ſuch and ſuch diſeaſes, incurable, and rather detract from nature and art, than confeſs, that thoſe two could do what ordinary phyſick could not; but even now, I fear, there are but too many, who, though they will not openly affirm, that ſuch and ſuch diſeaſes are abſolutely incurable, yet if a particular patient, troubled with any of them, be preſented, they will be very apt to undervalue (at leaſt) if not deride thoſe, that ſhall attempt and hope to cure him.

Examples of ſome unexpected and ſtrange cures.

And I am apt to think, that many a patient hath been ſuffered to die, whoſe life might have been ſaved, if phyſicians would have but thought it poſſible to ſave it. And therefore I think it were no ill piece of ſervice to mankind, if a ſevere collection were made of the cures of ſuch perſons, as have recovered after having been judged irrecoverable by the doctors; that men might no longer excuſe their own ignorance by the impotency of nature, and bear the world in hand, as if the art of phyſick, and their ſkill, were of the ſame extent. And the cures, that ſeem performed by nature her ſelf, need not be left out of ſuch a collection: for ſtill they ſhew what is poſſible to be done by natural means, to evacuate the morbifick matter, or alter its nature (how dangerous ſoever it is grown,) or how far the tone of a part, or ſtrength of the body may be vitiated or impaired, and yet be capable of ſome reſtitution. And ſuch an obſervation I received from our moſt experienced *Harvey*, when, having conſulted him about my weak eyes, he told me, among other things (as a very remarkable one) that he had once a patient (whoſe name and profeſſion he told me, but I remember not) that had a confirmed cataract in his eye; and yet upon the uſe of phyſick, to which he could not aſcribe ſo wonderful an effect, that cataract was perfectly diſſipated, and the eye reſtored to its wonted function. Which brings into my mind another obſervation, imparted to me a while ſince by that excellent and experienced lithotomiſt, Mr. *Hollyer*, who told me, that among the many patients ſent to be cured in a great hoſpital (of which he is one of the chirurgeons) there was a maid of about 18 years of age, who, without the loſs of motion, had ſo loſt the ſenſe of feeling in the external parts of her body, that when he had, for trial ſake, pinned her handkerchief to her bare neck, ſhe went up and down with it ſo pinned, without having any ſenſe of what he had done to her. He added, that this maid having remained a great while in the hoſpital without being cured, Dr. *Harvey*, out of curioſity, viſited her ſometimes, and ſuſpecting her ſtrange diſtemper to be chiefly uterine, and curable only by hymeneal exerciſes, he adviſed her parents (who ſent her not thither out of poverty) to take her home, and provide her a huſband, by whom, in effect, ſhe was, according to his prognoſtick, and to many men's wonder, cured of that ſtrange diſeaſe. That in acute ſickneſſes perſons given over by the phyſicians may recover, the more judicious, even of thoſe Galeniſts, that are of a deſpondent temper, will not deny. For not only *Celſus* gives us this ſober admonition, *Neque ignorare oportet in acutis morbis fallaces magis notas eſſe & ſalutis & mortis:* 'Nor may we be ignorant, that in acute diſeaſes, the notes of life or death are 'more fallacious:' But even *Hippocrates* himſelf, who was ſo ſkilful in prognoſticks, confeſſes, that *Morborum acutorum non in totum certæ ſunt prænunciationes neque ſalutis neque mortis:* whence the French have a proverbial ſaying, that *Il vaut mieux eſtre condamné* *par les medicins, que par le prevoſt des mareſchaux*; as if in Engliſh we ſhould ſay, "it "is better to be condemned to die by the doctor, than by the judge." And even in chronical diſeaſes, where events are wont much better to anſwer phyſicians predictions, there are ſometimes ſuch cures performed, as may encourage human induſtry, and keep a ſick man's friends from forſaking the cure of him, till life it ſelf hath unqueſtionably forſaken him. For not only it hath been not unfrequently ſeen, that divers perſons, who have been given over by ſome phyſicians, have been cured by others, perchance rather more lucky than more ſkilful; but thoſe, that have been given over, and that too (ſometimes rather upon the believed incurableneſs of the diſeaſe, than the perſonal condition of the patient) even by judicious and experienced phyſicians, if ſuch as are acquainted but with the ordinary remedies, have been recovered by the uſe of extraordinarily powerful, and eſpecially, chymical phyſick. Of ſuch cures I have ſometimes met with a few, which, becauſe I may elſewhere relate, I ſhall now only mention, on this occaſion, what I have heard concerning the cures of cancers, performed by Dr. *Harberfeld*, one of the principal phyſicians of *Bohemia*. And among other relations of this kind, made me by credible perſons, I cannot omit one, that was of a certain Engliſh woman, of ſixty and odd years of age, who had long lain in an hoſpital in *Zeeland*, ſick of a cancer in the breaſt, and by this doctor was, with one ſingle inward remedy, perfectly cured in the ſpace of three weeks. For this relation was made me by perſons of very ſtrict veracity, the one a doctor of phyſick, who was an eye-witneſs of the cure; the other a child of *Cornelius Drebell*'s, who not only ſaw the cure, but knew the woman before, and out of charity brought her to him, that healed her. The ſame perſons likewiſe informed me, that the chymical liquor the doctor conſtantly made uſe of, does, in the doſe of about a ſpoonful or two, work ſuddenly and nimbly enough by vomit, but hath very quickly ended its operation; ſo that within an hour or leſs, after the patient hath taken it, he is commonly well again, and very hungry. And they having preſented me ſome ſpoonfuls of this liquor, I find the taſte to be offenſive enough, and not unlike that of vitriol, which, by the taſte and emetick operation, I gueſs to be, at leaſt, its principal ingredient, however it be prepared. The ſame perſons aſſured me, that having obtained of Dr. *Harberfeld* a good quantity of his ſpecifick, they had been (in *England*, as well as elſewhere) partly eye-witneſſes, and partly performers of wonderful cures, by the help of it alone under God, in the king's-evil. Inſomuch that an eminent gentleman of this nation, now alive and healthy, hath been cured by it, when the king's-evil had brought his arm to that paſs, that the chirurgeon had appointed a time to cut it off. And with the ſame liquor, only taken inwardly, they profeſs themſelves to have ſeen and done divers cures of inveterate external ulcers, whoſe proud fleſh, upon the taking of it is wont to fall off, and then the ulcer begins to heal at the bottom; but of the recent effects of this liquor, we may elſewhere, perhaps, further entertain you. That ſuffuſions or cataracts may, by a mutual operation, be cured even in a patient, that was born with them, I formerly told you, when I related the cure done by my ingenious acquaintance, Mr. *Stepkins*, on a gentlewoman of about eighteen years of age, that brought a couple of cataracts with her into the world. And I remember, I was ſome while ſince in the company of another woman, who told me, that ſhe was brought to bed of five children (if I much miſtake not the number) ſucceſſively; of which ſhe ſaw not any in a long while after, by reaſon of a couple of ſuffuſions, that had many years blinded her; and yet now, by the help of a Dutch oculiſt of my acquaintance, ſhe ſees, and reads well, and hath freely enjoyed the reſtored uſe of her eyes for ſome years already.

Examples of cures of cancers.

An example of the cure of one, that was born with a cataract in the eye. And other examples of cataracts ſtrangely cured.

But theſe are rather chirurgical, than medicinal cures; and therefore we ſhall ſubjoin the mention of a very memorable obſervation of the learned *Petronius*, which being collated

*Alexand. Trajan. Petronius,* lib. 5. De morb. Gallico, c. 1. apud Schenckium in obſerv. l. 1.

collated with that a little above recited from Dr. *Harvey*, they may ſerve to keep each other from paſſing for incredible: *Quidam* (ſays our author) *qui antequam morbo Gallico afficeretur, altero oculo cæcus erat, ſuffuſione denſiſſima (vulgus cataractam vocat) oculum occupante, hydrargyri inunctione à morbo Gallico, et à ſuffuſione, quod maximè mirum eſt, evaſit. Neque à ratione alienum eſt inunctione illa cataractas poſſe diſſolvi, cum frequens experientia doceat præduros tumores ex pituita craſſa & concreta genitos, illitu hydrargyri potenter diſſolvi.* ‘ One, who before he fell into the French pox was blind of a cataract ‘ in one of his eyes by being anointed with quick-ſilver, was recovered, not only from ‘ the chief diſeaſe, but (which was moſt ſtrange) from his cataract. Nor is it irra‘ tional, that cataracts ſhould be diſſolved by ſuch anointing; when experience teacheth, ‘ that hard tumours clogged together of pituitous matter are powerfully diſſolved by ‘ mercurial inunctions.’

Examples of the cure of the dropſy and gout.

I NEED not tell you what ſad prognoſticks phyſicians are wont to make of dropſies, eſpecially of that ſort, which they call *Aſcites*. And indeed the event does but too frequently juſtify their predictions, when none but ordinary remedies are imployed. But I remember, that being acquainted with an ingenious perſon, that was very happily cured of a dropſy, and inquiring who it was, that had performed the cure; I was informed, that that, and a multitude of the like, had been wrought by a German phyſician, of whom, and of his remedy, I had heard much commendation in *Holland*, where he lived. And though on divers occaſions I found him a modeſt man, and accordingly, when I aſked him concerning his cures of the dropſy, he anſwered me, that he neither did, nor would undertake to cure ſo formidable a diſeaſe; yet he ſcrupled not to tell me, that as far as he had hitherto tried, he had one remedy, which had not failed him, though he had tried it upon perſons of differing ages, ſexes, and complexions. But of this ſpecifick more hereafter. For, at preſent, I muſt proceed to take notice, that as incurable a diſeaſe, as the radicated gout is thought to be, (eſpecially in patients not very temperate;) and as tedious a courſe of phyſick, as one would expect to be requiſite to the cure of it, in caſe it can be cured; yet I have been ſeveral times viſited by an honeſt merchant of *Amſterdam*, who was there noted for his wealth, and his ſkill *in arte tinctoria*. This man, ten or twelve years ago, had been for a long time ſo tormented with the gout, both in hands and feet, that his fits would ſometimes vex and confine him for a great part of the year, and not leave him without hard knots, as unwelcome pledges of their return: but once, that he was tortured to a degree, that made him much pitied, one came and informed him of an empirick, who had received from a great chymiſt, who had lodged in his houſe, a ſecret, with which he had already throughly cured many in a ſhort time: whereupon ſending for this perſon, and offering him any thing for ſome relief, the other refuſed to take above ten crowns, which, as it ſeems, was the uſual rate for the cure, and would not receive that neither, until the reality of it had been evinced by the patient's continuing about ſix months well. And accordingly, with a very few doſes of a certain powder and tincture, the merchant was quickly freed, not only from his pains, but from his gouty tophy. And though he indulged himſelf the drinking of Rheniſh wine very freely, yet he never had a fit ſince, as himſelf aſſured me one morning, wherein, for exerciſe ſake, he walked five or ſix miles to give me a viſit; adding, that the man that cured him, dying ſuddenly, never could diſcover what the ſecret was, wherewith ſo many had been freed from a diſeaſe, that does ſo often mock the ſkill of the greateſt doctors.

I MIGHT, perhaps, if I had leiſure, relate to you ſome other ſtrange ſtories, which may invite you to think, that as the naturaliſt's ſkill in chymiſtry, and other arts retaining to phyſiology, may much aſſiſt him to diſcover more generous remedies, than are yet uſual; ſo the knowledge of ſuch remedies may, in divers caſes, make a happy change in the rules of prognoſticating, what will prove the courſe and event of a ſickneſs. But I ſhall not, at preſent, particularly conſider any more than one diſeaſe, namely, the ſtone in the bladder. For whereas it is by moſt, even of the judicious phyſicians, unanimouſly pronounced incurable by phyſick in what perſon ſoever, if it deſerve the name of a ſtone, and be too big to be voided whole, the remedileſſneſs of this diſeaſe may be juſtly queſtioned. I remember the famous *Monardes*, treating of the ſeed of a Peruvian plant, which they call *Chalchoos*, tells us, that it is highly eſteemed by the inhabitants of the country it grows in, and affirmed not only to be diuretick, and to bring away gravel, but to break the ſtone in the bladder itſelf, if it be not too much hardened: *Ejuſque rei* (adds he) *tam multa proferunt exempla, ut admirationem mihi pariat:* ‘And they urge many inſtances of it even to my admiration.’ He tells us indeed, that he is of opinion, that nothing but ſection can cure the ſtone of the bladder: *Aiunt tamen*, ſaith he, *illius ſemen* (of the *Chalchoos*) *tritum, ex aqua aliqua ad eam rem idoneâ ſumptum, calculum in lutum diſſolvere, quod excretum denuo concreſcit, & in lapideam duritiem convertitur. Adoleſcentem vidi, cui hoc obtigiſſe ſcio; is cum veſicæ calculo torqueretur, idque à lithotomis, qui calculum deprehenderant, intellexiſſem, & ex ſymptomatis quæ patiebatur agnoſcerem; hominem, veris initio, ad fontem, qui à Petro nomen habet, ablegavi, ubi cùm duos menſes hæſiſſet, à calculo liberatus redit, & lutum omne, quod paulatim ejecerat, dènuo in lapidum fragmenta concretum in charta ſecum retulit.* ‘Yet they ſay, that the ſeed of the *Chalchoos*, ground and taken in any proper water, doth diſſolve the ſtone into a very dirt, which being voided, doth harden again into a ſtony ſubſtance. I ſaw a young man, to whom (upon my knowledge) this accident befel. When he was tormented with the ſtone in the bladder, which I underſtood both by the lithotomiſt who felt it, and by the ſymptoms which he ſuffered; I ſent him to a fountain, which takes its name from St. *Peter*: when he had ſtaid there two months, he returned free from the ſtone, and brought home with him all the dirt, which he had voided by degrees, in a paper, coagulated as it were into fragments of ſtone.’ Which paſſage, I wonder ſuch a writer ſhould immediately annex to the declaration of an opinion, that muſt appear confuted by it, to a reader, that conſiders not ſo much what is thought, as what is proved.

Examples of the cure of the ſtone.

The very learned and experienced Dr. *Gerard Boot*, of whoſe ſkill you, *Pyrophilus*, have found very good effect in your ſelf, and who was one of the two profeſſors, that writ the *Philoſophia naturalis reformata*, had a very famous remedy (which now he is dead, I intend, God willing, to communicate) againſt the ſtone; and with it he told me, that he had very often cured that diſeaſe in the kidneys: but for the ſtone in the bladder, he thought it impoſſible to be diſſolved; which circumſtances I recite, that you may the more readily believe what he told me a little before his death; namely, that he had cured lately one Mr. *Moulin* of a real ſtone in the bladder; adding, that he could not brag of being the inventor of that remedy he had employed, having but lately learned it of a country gentleman, whom going to viſit laſt ſummer, he ſaw a load of *Perſicaria*, or arſmart, brought to him by ſome of the country people; and deſiring to know what he intended to do with ſo vaſt a quantity of it, the gentleman replied, that he yearly uſed as much, having by the water of it, made by bare diſtillation in a common roſe-water ſtill, cured ſo many of the ſtone, even in the bladder, that he was uſually ſollicited by patients, numerous enough, to exhauſt all the liquor which he yearly prepared.

The uſe of Perſicaria for that cure.

What we, *Pyrophilus*, have obſerved concerning this excellent liquor, of which we uſe to preſcribe a draught every morning for ſome months together, we may elſewhere have occaſion to relate. But now we ſhall go on to tell you, that being ſome years ſince in *Ireland*, I met with an ancient empirick, who was very famous in thoſe parts for cutting of the ſtone of the bladder, and for curing ſore eyes. This man having given (in the parts where I then was, and whilſt I was there) ſome good proof of his ſkill, I ſent for him to me, upon the account of a ſuſpicion I long had of the ſtone in the bladder; which, upon ſearch, he aſſured me I was free from, and ſo (God be praiſed) I have afterwards found it. He was more a traveller than a ſcholar, and yet finding him, to my wonder, very modeſt and ſober, I inquired of him, whether he had never any where met with a remedy, that could diſſolve the ſtone in the bladder, offering him much more for a cure of that kind, than he would require as a lithotomiſt. He anſwered me, that he could cure no man of a confirmed ſtone, but by the help of his knife; but if the ſtone conſiſted of a lump of gravel not very firmly cemented together, he had, by a certain inward remedy he uſed, and a dextrous way of cruſhing the ſtone from without with his fingers, ſo broken the ſtone, partly by crumbling it, and partly by diſſolving the cement, as to make it avoidable by urine. And he added, that he had formerly cured a citizen of *Cork*, of a good large ſtone of the bladder, (for where I then was, he gave a proof of his ſkill, in telling before-hand thoſe he was to cut, the bigneſs and ſhape of the ſtones, that troubled them.)

Inſtances in other happy medicines for the ſame diſeaſe.

PASSING afterwards by *Cork*, I ſent an intelligent ſervant to inquire after this citizen; but, he being caſually abſent, his wife ſent me, by my man, a relation very agreeable to that, which he had made me. The receipt I purchaſed of him, and though it ſeem not very artificial, yet I ſuppoſe you will not quarrel with me, for annexing ſo experienced a one, to the end of this eſſay. But becauſe this remedy needed the aſſiſtance of a manual operation, we ſhall further proceed to tell you, that *Cardan*, as he is quoted by *Helmont* (for I have not now his works by me) relates, that in his time there rambled a man over *Lombardy*, who did commonly, and in a few days, by a certain liquor which he adminiſtred to his patients, ſafely, ſpeedily, and certainly cure thoſe, that were troubled with the ſtone in the bladder: adding (ſaith *Helmont*) his judgment, that he doubted not of this man's being in hell, for having, when he died, envied mortals ſo excellent an art.

De lith. c. 7. num. 14.

I INSIST not on the teſtimony, that the ſame *Helmont* gives to *Paracelſus* of his curing the ſtone, though he often handle him very ſeverely in other places of his writings, becauſe that the epitaph of *Paracelſus* (out of which he labours to prove his having cured the ſtone) makes no expreſs mention of it. Nor ſhall I enumerate thoſe paſſages, from whence the ſame *Helmont*'s followers collect, that he himſelf was able to cure that diſeaſe, by the reſolution of *Paracelſus* his *Ludus*; but this experience hath evinced to me, that a much ſlighter preparation of that ſtone, than was mentioned by *Paracelſus* and *Helmont*, hath been able to do more in that diſeaſe, than a wary man would readily believe. But to detain you no longer on this ſubject, I ſhall only add, that *Wilhelmus Laurembergius*, a learned phyſician, and profeſſor at *Roſtoch*, hath told the world, how he cured himſelf of a confirmed ſtone of the bladder, by the uſe of prepared millepedes (by ſome in *England* called wood-lice) and other remedies, which he hath particularly recorded in the hiſtory, which he hath publiſhed, and I have ſeen of this admirable cure; which having been epitomized by *Sennertus*, and other eminent phyſicians, I ſhall not need to inſiſt on it. And the arguments alledged (even by the moſt judicious) againſt the curableneſs of the ſtone, though very plauſible, ſeem not to me unanſwerable; for whereas firſt they appeal to the innumerable fruitleſs attempts, that have been made to cure great princes, and rich men, without cutting, that argument drawn from experience may, by the former experiments, be anſwered, eſpecially ſince *Horatius Augenius* (upon whoſe account *Laurembergius* tried millepedes) tells us, not only that he cured a young man at *Rome*, that was going to be cut of the ſtone, but that the Jeſuit, that chanced to confeſs this youth, and perſuaded him to the uſe

The uſe and ſucceſs of millepedes.

of millepedes, had experimented their efficacy both upon himſelf and others. And indeed we ourſelves have found them to be highly diuretick and aperitive.

And whereas it is next objected, that medicines muſt neceſſarily loſe their efficacy before they can reach the bladder, I confeſs, that for the moſt part, it is very true; but yet that it is poſſible for ſome medicines to retain their nature, after many alterations and digeſtions, we have elſewhere declared. And in our preſent caſe, we not only find, that turpentine and aſparagus do manifeſtly affect the urine (as I have often obſerved in my own, and almoſt any man may obſerve it in his;) but that which is moſt to our purpoſe, rhubarb tinges the urine of thoſe, that have taken any quantity of it. And laſtly, whereas it may be yet further alledged, that not only there hath not been yet a liquor found capable of diſſolving ſo ſolid a body as a ſtone; but, if there were, it muſt neceſſarily be ſo corroſive as to deſtroy the patient, by fretting his ſtomach, or guts, or bladder, which are parts ſo much more tender: to the firſt part of this plauſible objection it may be replied, that even good vinegar will diſſolve not only thoſe ſtony concretions, called *lapides cancrorum*, which, like the *calculi* we treat of, are formed in the bodies of animals, but even the more hard and ſolid body of coral, which will loſe but little of its weight, in a fire, that would waſte a great part of the *Duelech*: and that the bare juices of vegetables (ſuch as lemons and barberries) will readily diſſolve both pearl and coral, is known even to the apothecaries boys. Indeed, what *Paracelſus* and *Helmont* relate of their alkaheſt, with which they prepare their ſpecifick againſt the ſtone, and with which the latter of them, if not both, pretend to be able to reduce, not only the ſtone they call *ludus*, but all other ſtones, vegetables, minerals, animals, &c. into inſipid water, is ſo ſtrange (not to ſay incredible) that their followers muſt pardon me, if I be not forward to believe ſuch unlikely things, till ſufficient experience hath convinced me of their truth.

The argument, concerning the incureableneſs of the ſtone, anſwered.

But yet I muſt not conceal from you, that a chymiſt, whom you have often ſeen, adviſed with me ſeveral times about the way of preparing this immortal liquor, (as *Helmont* calls it) and that, when we had agreed, that ſuch a way was the moſt promiſing, he proſecuted it ſo long, and ſo induſtriouſly, that at length he obtained, and ſhewed me a liquor, which (though it ſeemed to me far ſhort of the alkaheſt) I confeſs I admired; and not I alone, but our ingenious friend Dr. C. (who had been imployed into ſeveral parts of *Europe*, by a rich and curious princeſs, to purchaſe rarities) agreed with this chymiſt, to give two hundred crowns for a pint of this menſtruum; and confeſſed to me withal, that he ſaw him, with this liquor, not only diſſolve common ſulphur, and bring it over the helm, but reduce antimony into ſweet cryſtals: with a few of which it was, that he (I mean Dr. *C.*) to the wonder of many, did, without purge or vomit, cure our good friend Sir *C. C.* of a very radicated and deſperate diſeaſe, as the reſtored patient ſoon after told me. And to the ſecond part of this objection it may be anſwered, that if we knew and conſidered well, how many of the operations of natural bodies depend upon the ſuitableneſs and difference of the figures of their parts, and the pores intercepted between them, the number of impoſſibilities would not, perhaps, be thought ſo great, as by many learned men it is.

That there may be a liquor able to diſſolve the ſtone, that may not be corroſive to any other part.

That it is very poſſible for a body to have an effect upon another determinate body, without being able to operate in like manner upon a multitude of other bodies, which may ſeem more eaſy to be wrought on by it; may appear by the loadſtone, which will draw and work only upon iron, and (which is but refined iron) ſteel, but not upon wood, or ſtraws, or any of thoſe innumerable concretes, that are lighter, and of a more open texture, than the heavy and ſolid body, which it attracts. And to give you an inſtance, that comes nearer to our caſe, quickſilver, that will not corrode our ſkin, nor ſo much as taſte ſharp upon our tongue, will yet readily diſſolve that moſt compact body of gold, which even aqua fortis, that can inſinuate it ſelf into all other metals, and corrode them, will not meddle with; though the ſame quickſilver will not diſſolve iron, which yet aqua fortis will very nimbly fret aſunder. So that, although I dare not confidently believe all, that I have found averred, even by eminent and learned chymiſts, of their having made or ſeen liquors, which, without appearing any way ſharp to the tongue, would diſſolve gold and ſilver, and other hard compact bodies; becauſe I have not yet my ſelf ſeen any ſevere and ſatisfactory trial made to evince the efficacy of inſipid diſſolvents: yet, by reaſon of divers things I have read and heard, and of ſome things too I have ſeen, I dare not peremptorily deny the poſſibility of ſuch menſtruums. And who knows, but that in nature there may be found, or by art there may be prepared, ſome liquor, whoſe parts may have ſuch a ſuitableneſs to the pores of a human *calculus*, as thoſe of quickſilver have to the pores of gold; and yet may as little work upon the reſt of the body, as we have obſerved the ſame quickſilver to do upon iron, (which yet is a much more porous and open metal) even when it hath been diſtilled in iron veſſels? And as to that part of the objection, wherein the ſtrength of it chiefly lies, let me tell you, *Pyrophilus*, that I have ſometimes, for curioſity's ſake, taken an egg, and ſteeped it in ſtrong vinegar for ſome days, and by taking it out, and ſhewing, that the ſhell was ſo eaten away, that the egg could be ſqueezed into unuſual forms, but the thin ſkin, that involves the white, continued altogether unfretted, I convinced an ingenious man, that the operation of diſſolvents are ſo determined by the various textures of bodies, on which they are employed, that a liquor, which is capable to corrode a more hard and ſolid body, may be unable to fret in the leaſt another more ſoft and thin, if of a texture indiſpoſed to admit the ſmall parts of the menſtruum. And I muſt confeſs to you, *Pyrophilus*, that one thing, among others, which hath made me backward to affirm with many learned men, that there can be no potent diſſolvent, that is not corroſive enough to fret in pieces the parts of a human body, hath been a ſtory, which I divers years ſince, chanced to meet with in the learned *Sennertus*'s *Paralipomena*, where, though he relates it to another purpoſe, yet it is ſo pertinent to our preſent deſign, and in it ſelf ſo ſingular, not to ſay matchleſs, that I cannot forbear to mention it here on this occaſion. He tells us then, that in the end of the year 1632, *Johannes Neſterus*, an eminent phyſician, and his great friend, informed him, that there lived at that time in the neighbourhood, and belonging to a nobleman of thoſe parts, a certain Lorrainer, whom he alſo called *Claudius*, ſomewhat low and ſlender, and about 58 years of age: *Hic* (ſaith he) *nihil fœtidum, nihil injucundum abhorret; vitra, lapides, ligna, carbones, oſſa, leporinos & aliorum animalium pedes cum pilis, lineos, laneoſque pannos, viva animalia, & piſces adhuc ſalientes, imò etiam metalla, patinas & orbes ſtanneos dentibus confringere & vorare ſæpiſſimè viſus eſt. Vorat præterea lutum, ſevum & candelas ſebaceas, integras teſtes cochlearum, animalium ſtercora, cum primis bubulum calidum adhuc, prout è matre venit: potat aliorum urinas cum vino & cereviſia mixtas. Vorat fœnum, ſtramen, ſtipulas, & nuper duos mures viventes adhuc deglutivit, qui ipſius ventriculum ad ſemihoram uſque creberrimis morſibus lancinarunt; &, ut brevibus complectar, quicquid illi à nobilibus devorandum offertur, viliſſimâ mercede propoſitâ, dictum ac factum, ingurgitat, ita ut intra paucos dies integrum vitulum crudum & incoctum cum corio, & pilis ſe eſtaturum promiſerit. Teſtes inter alios quamplurimos ipſe ego ſum, quippe qui, &c.* ‘He loaths nothing that ſtinks, or is otherwiſe unpleaſant. He hath been often ſeen to chew and ſwallow glaſs, ſtones, wood, bones, the feet of hares, and other animals, together with the hair; linen, and woollen cloth; fiſhes, and other animals alive; nay, even metals, and diſhes, and globes of tin: beſides which, he devours ſewet, and tallow-candles, the ſhells of cockles, and the dungs of animals, eſpecially of oxen, even hot, as ſoon as it is voided. He drinks the urine of others mixt with

Examples of thoſe, who could digeſt metals and glaſs.

Medicus Rochlizenſis.

‘ wine or beer; he eats hay, ſtraw, ſtubble, and lately he ſwallowed down two living
‘ mice, which for half an hour continued biting at the bottom of his ſtomach; and,
‘ to be ſhort, whatſoever is offered him by any noble perſons, it goes down with him
‘ without more ado upon the ſmalleſt reward, inſomuch that within a few days he hath
‘ promiſed to eat a whole calf raw, together with the ſkin and hair. Among divers
‘ others, I my ſelf am a witneſs of the truth of theſe, *&c.*’ To this and the following part of the letter, *Sennertus* adds, that not having, during ſome years, heard any thing concerning this *Claudius*, he ſent about four years after to the ſame phyſician, Dr. *Neſterus*, to enquire what was become of him; and that the doctor ſent him back a letter of the miniſter of the church of that place, by way of confirmation of all the formerly mentioned particulars, and anſwered himſelf, that the Lorrainer, whom he had long hoped to diſſect, was yet alive, and did yet devour all the things mentioned in his former letter, but not ſo frequently as before; his teeth being grown ſomewhat blunter by age, that he was no longer able to break bones and metals. Some other examples of this nature, though none ſo ſtrange, we have alſo met with in writers of good credit, and eſpecially that of the glaſs-eater, recorded by *Columbus* in his excellent anatomical obſervations; of which alſo *Sennertus* makes mention, as we ſhall ſee by and by, and with which we may elſewhere entertain you to another purpoſe. And not long ago there was here in *England*, a private ſoldier (who, for aught I know, is yet alive) very famous for digeſting of ſtones. And a very inquiſitive man, that gave me the accurateſt account I have met with concerning him, aſſures me, that he knew him familiarly, and had the curioſity to keep in his company for twenty-four hours together to watch him, and not only obſerved, that he eat nothing in that time, ſave ſtones (or fragments of them) of a pretty bigneſs, but that his groſs excrement conſiſted chiefly of a ſandy ſubſtance, as if the devoured ſtones had been in his body diſſolved and crumbled into ſand. But let us not omit, that to the ſecond epiſtle above mentioned *Sennertus* adds this reflection, not impertinent to our purpoſe: *Cauſam* (ſays he) *hujus voracitatis, etiam in cadavere, invenire proculdubio erit difficillimum. Poſſet quidem ad illud, quod in cadavere Lazari vitrivoracis obſervavit Columbus, quidam confugere; & ſtatuere quartam illam nervorum conjugationem, quæ guſtus gratia in hominibus à natura producta eſt; neque ad palatum, neque ad linguam pertendere. Verum hoc modo ſaltem guſtus aboliti cauſa redderetur, nondum verò cauſa daretur, cur res tam miras aſſumere ſine ventriculi læſione, imò concoquere potuerit. Quæ proculdubio in* ἰδιοσυγκρασία *& peculiari conſtitutione ventriculi & inteſtinorum quærenda eſſet; quæ tamen oculis inveſtigari non poteſt, ſed ſaltem ex effectu patet:* ‘ To
‘ find in the carcaſs the cauſe of this voracity, will be, queſtionleſs, very difficult.
‘ Some one perchance would refer it to that, which *Columbus* obſerved in the carcaſs of
‘ *Lazarus* the glaſs-eater, and reſolve, that the fourth conjugation of nerves, which
‘ nature ordained for taſting, comes neither to the palate, nor the tongue: but ſo
‘ there would only be rendered the cauſe of this want of taſte, and not why he ſhould
‘ be able to take ſuch uncouth things, without offence to his ſtomach, and digeſt
‘ them, which without doubt ought to be the particular and ſingular conſtitution of
‘ his ſtomach and guts, which yet may not appear to the eye by the effects.’ And indeed this memorable ſtory ſeems to argue, not only what we have already alledged it to prove, but alſo that a menſtruum not ſo corroſive as to fret the body, may diſſolve ſtones, metals, and other compact ſubſtances. And ſince one liquor, prepared by nature only, could in this man's ſtomach diſſolve that great variety of bodies above enumerated, why ſhould it be thought, that the alkaheſt, or ſome other menſtruum, wherein nature is ſkilfully aſſiſted, and to the utmoſt heightened by art, ſhould not be able to diſſolve concretes of very differing textures? For though chymiſts muſt acknowledge, that ſuch common menſtruums, as will diſſolve one body, will not often-

times meddle with another; as aqua fortis will diſſolve ſilver, and not gold; and if by ſal armoniac you turn it into aqua regis, it will indeed diſſolve gold, but then it will not ſilver: yet ſince that may be ſuppoſed to proceed rather from our want of ſkill to prepare the moſt potent menſtruum, than from the impoſſibility of one menſtruum's diſſolving great variety of bodies; why may not nature and art afford a menſtruum, whoſe variety of parts and figures, and, perhaps alſo, motion may give it ingreſs into bodies of very differing textures? as in our former inſtance, though aqua regalis will diſſolve gold, not ſilver, and aqua fortis ſilver, but not gold, yet quickſilver will diſſolve both, and copper, tin, and lead to boot.

**The deſcription of a menſtruum, prepared from a common bread, able to draw tinctures from precious ſtones, minerals, &c.**

If I were not at preſent under ſome reſtraint, I might tell you ſome things, that you would, perhaps, think no weak confirmations of the paſt diſcourſe. And however, ſince I have obſerved it to be the main thing, that keeps judicious men from ſeeking, or ſo much as hoping for nobler diſſolvents, that they are ſcarce to be perſuaded there can be conſiderably piercing menſtruums, that are not ſo proportionably corroſive; I will here acquaint you with a liquor, that may, I preſume, aſſiſt you to undeceive ſome of them. We take then ordinary houſhold brown bread (I like that of rye, but I have divers times uſed that of wheat) and when it is cut into ſlices, and ſomewhat dried, we almoſt fill a glaſs retort with it, and placing that in a ſand-furnace, by degrees of fire we draw off what will be made to come over, without much difficulty. The oil, as uſeleſs to our purpoſe, being by a tunnel, or a filter, ſevered from the reſt of the liquor, we alſo, by a gentle heat, free the ſpirit from ſome of its phlegm, which yet ſometimes we find no great neceſſity to do. And yet this ſpirit, which you will eaſily believe is no ſuch corroſive as aqua fortis, or other diſtilled liquors of mineral ſalts, will work upon the hardeſt ſorts of bodies, and perform things that chymiſts, counted of the judiciouſeſt, would not have us expect from the moſt ſharp and corroſive menſtruums now in uſe. For with this we have, in a ſhort time, and that in the cold, drawn tinctures (which is done by the ſolution of the finer parts of the concrete) not only from crude corals, and ſome of the more open minerals, but likewiſe from very hard ſtones, ſuch as blood-ſtone, and granates, (even unpowdered.) Nay, and though rubies ſeem to be the hardeſt bodies yet known ſave diamonds, (for I have learned from thoſe, that cut precious ſtones, that they can grind other gems with the powder of rubies, but not theſe with any powder, ſave their own, and that of diamonds;) yet have even theſe afforded me, in the cold, a not ignoble tincture. And not to anticipate what I may elſewhere have occaſion to tell you concerning the efficacy of this menſtruum, which is the ſame, that I have intimated, without naming it, in the laſt and another of the former eſſays; I ſhall now only add, that an expert chymiſt aſſures me he hath, but tells me not how, done greater matters with it, or the like; and that to ſatisfy my ſelf, that theſe high tinctures proceeded not from the ſtanding or digeſtion of the menſtruum (as we elſewhere obſerve concerning ſome other liquors) I not only tried, that from ſome minerals it will draw a much higher tincture than from others, and from ſome ſcarce any at all; but that it would, if kept by it ſelf, for many months continue clear and limpid. What further uſe I have made, or think others may make of this odd menſtruum, I muſt not, as I ſaid, at preſent expreſs; but returning to what I was diſcourſing concerning the cure of the ſtone, annex, that beſides what hath been objected againſt the poſſibility of making a liquor, which, without being highly corroſive, can be able to work upon ſtone; it may indeed be alſo alledged againſt the hopes we ſeem to countenance, that what hath cured the ſtone in one man's bladder, may be unable to do the like in another's. But firſt, the truth of that hath not been proved; and next, we highly value thoſe ſpecificks, that can remove agues, fluxes, and the like diſeaſes; though ſcarce any of them do alike ſucceed in all patients, eſpecially ſo as to ſecure them during their whole lives, from ever relapſing into the like diſeaſe; and beſides all this, it will be no ſmall matter to find, that the diſeaſe, in its own nature, is not incurable; and it would recompenſe men's induſtry to be able to free, even a few patients, from ſo painful and ſtubborn a diſeaſe. Which I have, rather than any other, choſen to inſiſt upon, becauſe it is ſo generally believed not to be curable by inward remedies in any perſon whatever.

*Helmont*'s argument from the providence of God cenſured.

BUT I have entertained you ſo long on this ſubject, that I muſt reſerve, for ſome other opportunity, what I have to ſay to you concerning the dropſy, and ſome other diſeaſes, commonly put into the catalogue of the incurable ones; and therefore ſhall now only tell you in general, that as on the one ſide I think the arguments, which *Helmont* and others draw from the providence of God, for the curableneſs of all diſeaſes, are not very cogent, and ſomewhat irreverent, (for God being not obliged any more to continue life or health to ſinful man, than to beaſts, that never offended him, we ought humbly to thank him, if he hath, among his creatures, diſperſed remedies for every diſeaſe, but have no right to accuſe him if he have not;) ſo on the other ſide, I am not much convinced by the grand argument alledged againſt *Paracelſus*, and the chymiſts, that hold all diſeaſes to be in their own nature curable, namely, that they themſelves many of them, (no nor even their very maſter) lived not to the age attained by many ſtrangers to chymiſtry.

The argument, that *Paracelſus* out-lived not the 47th year of his age, anſwered.

FOR this, that many of them (not deſtroyed by war, or outward accidents) died young enough, and conſequently by ſickneſs, and that *Paracelſus* himſelf out-lived not the 47th year of his age, is a much ſtronger objection againſt the men, than againſt their opinion; for it infers indeed plauſibly, that they had not ſuch remedies as they boaſted of, (ſince probably, had they had any ſuch, they would have cured themſelves with them;) but concludes not, that no ſuch remedies can be prepared by any other. And this you will be leſs apt to think irrational, if you conſider, how much more learned, ſober, and experienced it is poſſible for many a man to be, than *Paracelſus* appears to have been. For he ſeems not, by his writings, to have been any great logician or reaſoner; he manifeſtly deſpiſed many parts of learning uſeful to a phyſician; he lived not many years, and ſpent divers of thoſe few, which he lived, in an unſettled and diſadvantageous courſe of life; and yet this *Paracelſus* attained to ſome ſuch remedies, as both in his own and after-times have made him a very conſiderable perſon, in ſpight of all his indiſcretions and deficiencies. And among his other remedies, his famous *laudanum* did ſuch wonders, that *Oporinus* himſelf, in that ſhort account, which ſeems to be rather a ſatire than a narrative of his life, hath this paſſage of it: *De laudano* (ſaith he) *ſuo (ita vocabat pilulas inſtar murium ſtercoris, quas impari ſemper numero, in extrema tantùm morborum difficultate tanquam ſacram medicinam exhibebat) ita gloriebatur, ut non dubitarit affirmare ejus ſolius uſu ſe è mortuis vivos reddere poſſe; idque aliquoties, dum apud ipſum fui, re ipſa declaravit:* 'Of his *laudanum* (that name he gave to little pills, which in the extremity of diſeaſes he adminiſtered as a moſt divine medicine, always giving them in an odd number) he ſcrupled not to affirm, that by that medicine he could put life into thoſe, who were as good as dead; and that while I was with him, he made good in ſome experiments.' So ſignal a teſtimony coming from one, whom the Paracelſians call his fugitive ſervant, hired by his enemies to ſlander him under pretence of writing his life, deſerves not to be ſlighted: and though it manifeſtly contains an hyperbole, yet I do the leſs wonder at the hyperbole, by reaſon of thoſe ſtrange things, which your mother, and divers other of your friends, can tell you, they have ſeen performed in *England* by *Helmont*'s *laudanum opiatum*, (though much inferior to that of *Paracelſus*.) And I remember, that a friend of yours and mine, that is a great enemy to all kinds of chymical remedies, and was before alſo to chymiſtry,

The efficacy of *Paracelſus*'s laudanum.

miſtry, having begged of me a little bottle of it, which I had obtained from a friend of the younger *Helmont*'s, to whom he communicated the preparation, gave me a while after an account of ſuch cures, that had been performed, with that ſmall quantity, upon almoſt dying perſons, as I think it not diſcreet for me, that was not an eye-witneſs of them, to relate. And I remember too, that the ſame friend of young *Helmont*'s, being, at the perſuaſion of one woman, whom he had cured of a dangerous conſumption, called to another, that was thought to be dying of an aſthma, came to adviſe with me, whether he ſhould meddle with ſo deſperate a patient; telling me, that ſhe had been many years ſick of that ſtubborn diſeaſe, which, in proceſs of time, paſſing into an orthopnea, had at laſt put her, by want of ſleep (from which the violence of her ſickneſs had very long kept her) into a fever, and ſo deſperate a condition, that it was ſcarce expected ſhe ſhould live till the next morning. But I repreſenting to him, that her condition being avowedly deſperate, he might exerciſe his charity without danger to his reputation; and perſuading him to try *Helmont*'s *laudanum*, together with the ſpirit of man's blood (which we elſewhere teach you to prepare) he gave her that night a doſe of thoſe remedies, which made her both ſleep and breathe pretty freely; and a week after, he coming to viſit me, told me, he had caſually met his patient well and abroad in the ſtreets. But theſe are trifles to the cures, which *Helmont* relates to have been performed by our Iriſh *Butler*: for he tells us, that this man, by ſlightly plunging a little ſtone, he had, into almond-milk or oil, imbued thoſe liquors with ſuch a ſanative efficacy, that a ſpoonful of the former cured (and that without acquainting him with what was given him) a Franciſcan frier (a very famous preacher) of a very dangerous eryſipelas in the arm, in one hour; and one drop of the latter being applied in his preſence, to the head of an old laundreſs, that had been ſixteen years troubled with an intolerable hemicrania, the woman was preſently cured, and remained ſo to his knowledge for divers years. He adds almoſt as ſtrange a cure done in one night, upon a maid of his wife's, by anointing the part affected with four drops of that oil. He farther tells us, that the maſter of the glaſs-houſe at *Antwerp*, being troubled and made unwieldy with too much fat, begged ſome relief of *Butler*; who, having given him a little fragment of his little ſtone, with order to lick it nimbly with the tip of his tongue once every morning, I ſaw, ſaith *Helmont*, within three weeks, the compaſs of his waiſt leſſened by a ſpan, without any prejudice to his health. And to theſe, *Pyrophilus*, he adds ſome other narratives, which, though I confeſs I know not well how to believe, yet there are circumſtances, which keep me from daring to reject them. For firſt, as he well obſerves, that, which was moſt ſtupendous in this remedy, was but the ſmallneſs of the quantity. Next, a gentleman in *France* being not long ſince reported to have a fragment of this ſtone, and to have cured ſeveral perſons (and eſpecially one very dignified) of inveterate diſeaſes, by letting them lick it; my noble friend Sir *Kenelm Digby*, then in *France*, was ſolemnly requeſted from hence to inquire into the truth of that report, and anſwered, that he could not, upon examination, find it other than true. Beſides, *Helmont* not only relates theſe cures as an eye-witneſs of them, but tells us, how upon an occaſion, that he mentions, he once ſuſpected the efficacy of the oil; and that, without expecting, that it ſhould do any thing, he anointed it on the right arm and the ancles of his own wife, who had for ſome months been tormented with great pains in the former, and very great tumours in the latter of thoſe parts; and that, almoſt in a trice, motion was reſtored to her arm, and all the *œdema* of her legs and feet vaniſhed; adding, that at the time of his writing ſhe lived healthfully, and had done ſo ſince that recovery, during nineteen years. And this ſtory ſhe, long after her huſband's death, confirmed to our ingenious friend Dr. *C.* who is acquainted with her, and much extols her. Theſe circumſtances may be aſſiſted by two more very conſiderable

*Butler*'s great remedies.

*Helmont* in the treatiſe, which he entitles *Butler*.

conſiderable ones; the one is, that *Helmont* is the more to be credited in theſe relations, becauſe mentioning cures not performed by himſelf, but by others, and that by remedies unknown to him, he ſeems by theſe narrations, out of loyalty to truth, to eclipſe his own reputation: and the other is, that in a memorable ſtory, which we may elſewhere relate to you (being not here proper to inſert ſo long a one) you'll find an eminent and ſtrange teſtimony given to *Butler*'s ſecrets, by our famous countryman Dr. *Higgins*, whoſe confeſſion you will not doubt, if you conſider how rare a phyſician and chymiſt he was, how familiarly he lived in the ſame houſe with *Butler*, and how ſtudiouſly at laſt they endeavoured to take away each other's life.

But whatever be to be thought, *Pyrophilus*, of *Helmont*'s relation, we may well enough make this reflection on the other things, that have been delivered concerning formidable diſeaſes, that ſince the power of nature and ſkill may reach much farther than many diſtruſtful (not to ſay lazy) men have imagined, it will not be charitable to rely too much upon the prognoſticks, even of famous writers, when they tell us, that ſuch and ſuch diſeaſes, or patients in ſuch and ſuch conditions cannot poſſibly be cured: but rather to follow the ſober counſel of *Celſus*, *Oportet* (ſaith he) *ubi aliquid non reſpondet, non tanti putare authorem quanti agrum, & experiri aliud atque aliud.* 'Where a medicine anſwers not, we ought not ſo much to eſteem the author as the 'patient, and to try ſomewhat farther and farther.' And this great phyſician's authority I therefore make the moſt uſe of in the enſuing eſſays, becauſe he is accounted very judicious by the Lord *Verulam*, and other writers, that are unqueſtionably ſo themſelves.

De medicina, lib. 3. cap. 10.

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# ESSAY IV.

## *Preſenting ſome things relating to the Hygieinal part of Phyſick.*

THAT the dietetical part of phyſick, *Pyrophilus*, may, as well as the others, be improved by natural philoſophy, were not uneaſy to manifeſt, if my haſte would permit it: for it is known, that drinks make a very conſiderable part (ſometimes, perchance, amounting almoſt to the one half) of our aliments; and moſt drinks, as wine, beer, ale, mead, &c. conſiſt of fermented liquors. Now as on the one ſide the ignorance of the doctrine of fermentation, and of the wholeſome way of both preſerving liquors and making them pleaſant, doth queſtionleſs occaſion more than a few diſeaſes, which in divers places may be obſerved evidently to proceed from the unwholeſome quality of either ill-made or ſophiſticated drinks; ſo, on the other ſide, the diſtinct knowledge of the true nature and particular phænomena of fermentation would enable men to prepare a great variety of drinks, not only as harmleſs, but as beneficial as pleaſant.

That the knowledge of fermentation is uſeful to make our drinks wholeſome for aliment.

How much preparation may do to correct and meliorate both hard and liquid aliments, is notably inſtanced by the account, that we receive from both the French and Engliſh that inhabit the *Barbados*, *St. Chriſtophers*, and other *Carribee* iſlands, who ſolemnly inform us (what is atteſted alſo by *Piſo*, and other learned travellers, that write of it) that the plant mandioca (whoſe prepared root makes caſſavy, and which we have alſo ſeen flouriſhing here in *Europe*) to which the Indians are ſo much beholden, is a rank poiſon. And though I ſhall tell you, that having purpoſely inquired of a

How much ſimples may be altered by preparation, exemplified by the Indians making Caſſavi out of the poiſonous plant Mandioca. Odd unhandſome ways of their making drink from the ſame root. Hiſtory of the Barbados, pag. 29, 30, 31, 32.

very intelligent gentleman, who commanded an army of Europeans in *America*, what experience he had ſeen of the qualities of this plant, he told me, that between thirty and forty of his ſoldiers, having on a time (whilſt they were unacquainted with the country) either through ignorance or curioſity, eaten of it unprepared, it coſt moſt of them their lives. And yet this pernicious root, which ſome herbariſts call *yucca*, by the rude Indians ordering, comes to afford them both almoſt all their bread, and no ſmall part of their drink. For this root being grated, and carefully freed from its moiſture, by being included in bags, and very ſtrongly preſſed, till all the juice be ſqueezed out, it is afterwards dried in the ſun, and ſo made into meal, of which they make their bread. And this very root, though (as we ſaid) it be poiſonous, they cauſe their old and almoſt toothleſs women, for the better breaking and macerating it, to chew and ſpit out into water. This juice will, in a few hours, work and purge itſelf of the poiſonous quality, affording them a drink which they eſteem very wholeſome, and at the *Barbados* call *perino*, and account it to be the likeſt in taſte to our Engliſh beer, of any of thoſe many drinks, that are uſed in that iſland.

THIS naſty way of preparing drink, *Pyrophilus*, may ſeem ſtrange to you, as it did to me, when I firſt heard of it; but beſides the conſenting relations both of French and Engliſh concerning it, it may be confirmed by the ſtrange aſſertion of *Gulielmus Piſo*, in his new and curious *Medicina Braſilienſis*, where, having ſpoken of ſeveral of the Braſilian wines, he tells us, that they make liquors of ſeveral plants beſides the root of mandioca, after the ſame naſty manner. *Idem fit* (ſaith he) *ex mandioca, patata, milio Turcico, oryza, & aliis, quæ à vetulis maſtucantur, maſticataque multa cùm ſaliva exſpuuntur; hic liquor mox vaſis reconditur, donec ferveat, fæceſque ejiciat.* ‘The ‘ſame is made of mandioca, potatoe's, Turkiſh millet, rice, and other things, which ‘being chewed by old women, and ſpit together with much ſpittle, this liquor is ſtrait ‘put up into veſſels, and there kept, until it ferments and caſts down a ſediment.’

Vogage de Muſcovie & de Perſe, p. m. 23.

IN *Muſcovia* itſelf, notwithſtanding the unſkilfulneſs of that rude people, *Olearius* informs us, that the embaſſadors, to whom he was ſecretary, were preſented at one time with two and twenty ſeveral ſorts of drink. And at a country-houſe here in *England* (where I was, by a very ingenious gentleman, that is maſter of it, preſented with divers rare drinks of his own making) I was aſſured, that he had lately, at one time in his houſe, at leaſt the former mentioned number of various drinks, and might eaſily have had a greater, if he had pleaſed.

Of making drink from ſorts of coarſe bread.

AND on this occaſion, I am not willing to pretermit what is practiſed in ſome of our American plantations, as I am informed by the practiſers themſelves; where, finding it very difficult to make good malt of maiz, or Indian corn, (by reaſon of hindrances not to be diſcourſed of in few words) they brew very good drink of it, by firſt bringing the grain to bread; in which operation, the grain being both reduced into ſmall parts, and already ſomewhat fermented, is diſpoſed to communicate eaſily its diſſoluble and ſpirituous parts to the water it is boiled in. To which I ſhall add, that I have reaſon to think, that the art of malting may be much improved by new and ſkilfully contrived furnaces, and a rational management of the grain.

NOR are we alone defective in the knowledge of fermenting drinks, but even in that of the materials, of which drinks may be prepared.

The drinks in uſe in China.

Hiſtory of China, part 1. c. 1.

IN that vaſt region of *China*, which is enriched with ſo fertile a ſoil, and comprizeth ſuch variety of geographical parallels, they make not (as *Semedo* informs us) their wine of grapes, but of barley; and, in the northern parts, of rice, where they make it alſo of apples: but in the ſouthern parts, of rice only; yet not of ordinary rice, but of a certain kind peculiar to them, which ſerves only to make this liquor, being uſed in divers manners. And of the wine there drank, even by the vulgar, our author gives, us this character: The wine uſed by the common people, although it will make them drunk, is not very ſtrong or laſting; it is made at all times of the year, but the beſt only in the winter: it hath a colour very pleaſing to the ſight, nor is the ſmell leſs pleaſing to the ſcent, or the ſavour thereof to the taſte; take all together, it is a vehement occaſion, that there never wants drunkards, &c. And of the inhabitants of the kingdom of *Japan*, I remember alſo, *Pyrophilus*, that *Linſchoten*, in his deſcription of thoſe Iſlands, tells us, that they drink wine of rice, wherewith they drink themſelves drunk.

*Linſchoten*'s voyages, book 1. c. 26.

WE have here in *England*, at the houſe of our experienced mint-maſter, Dr. *Gordon*, taſted a wine, which he made of that ſort of cherries which are commonly called morello, that was, when we drank of it, about a year and a half old, but it was ſomewhat ſour, and needed ſugar. And therefore I ſhall rather take notice to you of my having ſince drank wine made of the juice of good, but not of extraordinary Kentiſh cherries, which, with the help of a *tantillum* of ſugar added in the fermentation, kept ſo well, that though it were above a year old when I taſted it, I found it a ſtrong and pleaſant wine, not inferiour to many wines, that are brought us from foreign parts. But this is nothing to what is averred upon his own experience, by a learned divine (to whom you, *Pyrophilus*, and I, am related) who affirms himſelf to have made out of ſome ſort of wild apples and pears, by bare fermentation, ſuch liquors, as though at firſt ſomewhat harſh, will not only keep divers years, but, at the end of two or three, attain ſuch ſtrength, and ſo pleaſingly pungent a taſte, that they may compare even with choice outlandiſh wines, and excel thoſe, that are not of the very beſt ſorts of them.

Of cherry wine.

Of excellent cyders.

BUT till we have in another eſſay an opportunity of preſenting you ſomething out of the obſervations of *Olearius*, the newly mentioned divine, and our own, concerning fermented liquors, we ſhall content our ſelves to manifeſt our want of curioſity about the materials, of which drinks may be prepared, by this, that the drinks of one whole country are oftentimes unknown to the inhabitants of another. That the wine made of rice, which we lately mentioned to be of frequent uſe in the kingdoms of *China* and *Japan*, is of little or none in *Europe*, I need not prove to you. I have been in divers places, where beer and ale, which are here the common drinks, are greater rarities than the medicated liquors ſold only in apothecaries ſhops. In divers parts of *Muſcovy*, and ſome other northern regions, the common drink is *hydromel*, made of water fermented with honey; and indeed, if a due proportion betwixt thoſe two be obſerved, and the fermentation be ſkilfully ordered, there may be that way, as experience hath aſſured us, prepared ſuch a liquor, both for clearneſs, ſtrength, and wholeſomeneſs, as few, that have not taſted ſuch a one, would readily believe.

Of hydromel.

THE French and Engliſh inhabitants of the *Caribbee* Iſlands, make, by fermentation, a wine of the dregs collected in the boiling of ſugar. A like to which *Piſo* tells us, that they make in *Braſil*, and commonly call *garapa*, which, though made by the mixture of water, the inhabitants are very greedy of; and when it is old, find it ſtrong enough to make them drunk. And how alſo in theſe colder countries a good wine may be made of only ſugar and water, we may elſewhere have occaſion to teach you.

Of ſugar wines.

Lib. 4. c. 1.

AND in *Braſil* they likewiſe, as the ſame author informs us, make a wine (unknown to moſt other regions of the world) of the fruit of *acaju*, which yet, upon his experience, he much commends; telling us, that it is ſtrong enough to inebriate, and may, he doubts not, be kept good many years; and that though it be aſtringent, yet both in himſelf and others he found it diuretical.

Lib. 4. c. 6.

Of other Braſilian and Barbados wines.

IN the *Barbados* they have many drinks unknown to us; ſuch as are *perino*, the plantane drink, *grippo*, punch, and the rare wine of pines, by ſome commended more than the poets do their nectar; ſome of which we therefore make not, becauſe the vegetables,

tables, whereof they are produced, grow not in theſe colder climates: but others alſo they have, which we have not, though they are made of plants to be met with in our ſoil; as for inſtance, the drink they call *mobby*, made of potatoes fermented with water, which, being fit to drink in a very few days, and eaſy to make as ſtrong almoſt as the maker pleaſeth, would be of excellent uſe, if it were but as wholeſome as it is accounted pleaſant.

IN the Turkiſh dominions, where wine, properly ſo called, is forbidden by *Mahomet*'s law, the Jews and Chriſtians keep in their taverns a vinous liquor made of fermented raiſins, after a manner, which (when we ſhall elſewhere acquaint you with it) you will eaſily diſcern to be capable of much improvement from the knowledge of fermentation. And indeed by the bare fermenting of raiſins and water, in a due proportion, without the help of barm, leaven, tartar, or other additament to ſet them a working, we have divers times, in a few days, prepared a good vinous liquor, which having for trial's ſake diſtilled, it afforded us greater ſtore than we expected, of inflammable ſpirit, like that of other wine.

The way to make wine of raiſins.

Of wines from the dropping or weeping of wounded vegetables.

BUT I have ſometimes wondered, that men had no more curioſity to try what drinks may be made of the juices obtainable by wounding or cutting off the parts of ſeveral trees, and ſome other vegetables: for that in the *Eaſt-Indies* their *ſura* is made of the liquor dropping from their wounded coco-trees, we have not long ſince out of *Linſchoten* informed you. And ſober eye-witneſſes have aſſured us, that in thoſe countries they have but too often ſeen the ſea-men drunk, by the uſe of liquors weeping out of the inciſions of wounded vegetables, and afterwards fermented.

AND that even in *Europe*, the alimental liquor, drawn by trees from the earth, may receive great alterations from them, before it be quite aſſimilated by them, may be gathered from the practice of the Calabrians and Apulians; who betwixt *March* and *November*, do by inciſions obtain from the common aſh-tree, and the *ornus* (which many botaniſts would have to be but a wild aſh) a ſweet juice, ſo like to the manna, adhering in that ſeaſon to the leaves of thoſe kind of trees, that the natives call it in their language, *manna del corpo*, or trunk manna. And leſt we ſhould think they draw all this ſweetneſs from the ſoil of that particular part of *Italy*, where they grow, you may be ſatisfied by the learned *Chryſoſtomus Magnenus*, in his treatiſe *de Manna*, that it is to be met with in ſeveral other places. And he adds, that in the dukedom of *Milan*, where he profeſſeth phyſick, there is no other manna uſed, than that, which is (as he ſpeaks) *vel è trunco expreſſum* (which he ſomewhere calls *manna truncinum*) *aut in ramis ſtriatim concretum*; and that yet it is ſafely and proſperouſly uſed.

De Manna, cap. 18.

Of the tears of the walnut-trees.

I HAD communicated to me, as a rarity, a ſecret of the king of *Poland*'s, which is ſaid to do wonders in many diſeaſes, and conſiſts only in the uſe of the liquor, which drops about the beginning of the ſpring from the bared and wounded roots of the walnut-tree: but becauſe I have not yet made trial of it my ſelf, I ſhall paſs on to obſerve to you, that in ſome northern countries, and even in ſome parts of *England* bordering upon *Scotland*, the almoſt inſipid liquor, that weeps in *March*, or the beginning of *April*, out of the tranſverſely wounded branches (not trunks) of the birch-tree, is wont to be uſed by perſons of quality as a preſervative from the ſtone; againſt which cruel diſeaſe, *Helmont* highly extols a drink made of this liquor and *ſemen dauci* and *beccabunga*, and I think not without cauſe. For not to mention all the commendations, that have been given me of it by ſome that uſe it, I have ſeen ſuch ſtrange relief frequently given, among others, to a kinſman of mine, to whom hardly any other remedy (though he tried a ſcarce imaginable variety) was able to give eaſe, (and in whoſe diſſected bladder, after another diſeaſe had killed him, a ſtone of many ounces was found) that I uſually every ſpring take care to provide a quantity of this water, with which alone,

The uſe of the tears of birch, with ſome other ingredients, for the ſtone.

alone, without the other ingredients mentioned by *Helmont*, my kinſman uſed to be relieved as long as he could keep it; which you may do the longer, by pouring upon the top of it a quantity of ſallad-oil, to defend it from the air; and perhaps alſo by diſtillation: by which (laſt named) way, I know an ingenious man, that is wont to preſerve it for his own uſe, and ſays, he finds it not thereby impaired in virtue. But the moſt effectual way, that ever I yet practiſed, *Pyrophilus*, to preſerve both this and other liquors and juices, is dextrouſly and ſufficiently to impregnate them with fume of ſulphur, which muſt be at divers and often times as it were, incorporated with the liquor by the due agitation; the manual operation belonging to this experiment, I may hereafter have occaſion to deſcribe more fully, together with the particular effects of it in ſeveral bodies. And therefore it may here ſuffice to tell you, that if you practiſe it carefully, you will, perhaps, think your ſelf obliged to thank me for the diſcovery of it, though a heedful reader may find it, not obſcurely, hinted in *Helmont*'s writings.

The ways to preſerve theſe liquors.

I MIGHT here annex the great commendation, which I have found given to this birch-water, by eminent writers, againſt the hot diſtempers of the liver, and divers other affections; and eſpecially how *Freitagius* commends it very much to dilute wine with: and adds, *Hæc eſt dulcacida & grati ſaporis, ſitim ſedat, viſcerum & ſanguinis fervorem temperat, obſtructiones reſerat, calculum pellit:* ‘ This birch-water hath a ſweet ‘ ſharpneſs, and very pleaſant taſte; it allays thirſt, and the dryneſs of the entrails; it ‘ tempers the heat of the blood; it opens obſtructions, and drives out the ſtone.’

The uſe of theſe tears of birch in hot diſtempers of the liver and hot catarrhs. In conſilio medicinali in catarrho calido pro principe quodam.

BUT I ſuppoſe you will think it high time for me to proceed to another ſubject; and indeed I ſhould not have ſpent ſo much time in diſcourſing of drinks, but that I am apt to think, that if there were greater variety of them made, and if they were more ſkilfully ordered, they might, by refreſhing the ſpirits, and inſenſibly altering the maſs of blood, prevent and cure (without weakening or much troubling the patient) almoſt as many diſeaſes, as the uſe of our common, unwholeſome and ſophiſticated wines is wont to produce.

FOR in fermentation, the ſulphureous (as chymiſts call them) the active, and the ſpirituous parts of the vegetables, are much better looſened, and more intirely ſeparated from the groſſer and clogging parts, in moſt mixts, than they are by the vulgar ways of diſtillation, wherein the concrete is not opened by previous fermentation. And theſe nobler parts being incorporated with our aliments, are with them received freely, and without reſiſtance carried into the maſs of the blood, and therewith, by circulation, conveyed to the whole body, where their operation is requiſite. And I remember, that diſcourſing one day with an eminently learned and experienced phyſician, of the antinephritical virtue of our common wild carrot-ſeed, fermented in ſmall ale; he ſmilingly told me, that he found its efficacy but too great; for having preſcribed it to ſome of his rich patients, who were wont frequently to have recourſe to him in their nephritical diſtempers, after the uſe of this drink for a pretty while, he ſeldom heard of them any more. And for your encouragement, *Pyrophilus*, to make trials of this nature, we will add, that though the ſeed it ſelf be not over-well taſted, yet being fermented in a due proportion with the liquor (we uſed an ounce and half of the ſeed, to a gallon of the ale) the drink compoſed of both taſted pleaſantly, almoſt like lemmon-beer.

The uſe of daucus ale, and proportion of the ſeed to the liquor.

AND that you may the leſs wonder at the efficacy of fermented liquors, it is worth conſidering, what virtue is aſcribed to the bare decoction of that herb, which the French and we call *Thé* or *Tè*, which is much magnified here; and as far as my little experience in my ſelf, and others (of which more hereafter) reaches, not altogether without cauſe: but among the Chineſe and the Japonians, it is the common drink of perſons of quality, by whom it is ſo highly praiſed, that the experienced *Tulpius*, in

Of Thé or Tè.

Obſ. lib. 4. cap. ult.

the new edition of his *Obſervations*, tells us, that one pound of the Japonical *T'chia* (as the natives call it) is not unfrequently ſold for one hundred pounds of ſilver; which is not to be wondered at, if they juſtly aſcribe to it, that in thoſe countries men are not ſubject to the ſtone, or the gout, and if but one half of the virtues he there attributes to it, be for the moſt part to be found in it.

Of animal drinks.

I MIGHT, when I told you of the variety of materials not uſed among us, have added one ſtrange drink, which a chirurgeon, that a while ſince lived at in the *Eaſt Indies*, told me, he ſaw much uſed thereabouts: they make it of the raw fleſh of goats, capons, and the like, which together with rice and moloſſes (or black coarſe ſugar) they put into a quantity of water, and diſtil it in an alembick till the liquor be ſtronger than brandy, (as they call common weak ſpirit of wine, or of lees of vinous liquors) and this *rack* (as the extravagant liquor is called) is often drank in hot weather, and found very comfortable: thoſe, that uſe it, prizing it much, as ſuppoſing it draws a nutritive and cheriſhing virtue from the fleſh, as indeed, if any quantity of the nobler parts of that do concur to the conſtituting of the liquor, it may probably be, at leaſt to divers bodies, very wholeſome in that country, where they find ſtrong drinks neceſſary to recruit their ſpirits, exhauſted by the exceſſive heat of the climate. As I remember, the experienced *Bontius*, in his *Medicina Indorum*, tells us, that the merchants travelling through the ſcorching deſarts of *Arabia*, *Perſia*, or *Turkey*, find it beſt to quench their thirſt by a draught of the ſpirit of wine, or elſe of the ſtrongeſt Perſian or Spaniſh wine.

Dialogo 3.

The uſe of brandy or wine in hot climates.

AND of the great uſe, if not neceſſity, of either brandy, or ſuch other ſtrong and ſpirituous drinks in the hot climates of the *Indies*, divers intelligent perſons of our own country have, upon their own experience, ſufficiently ſatisfied us.

The uſe of natural philoſophy to meliorate meats.

NOR, *Pyrophilus*, is natural philoſophy able only to improve our drinks, but the reſt of our aliments alſo: for not to mention, that experience hath aſſured us, that by ſkilfully contrived ovens (wherein the heat plays every way about the bread, without yet ſuffering any of the ſmoke or ſteams of the fire to come at it, and wherein what degree of heat you pleaſe may be continued from firſt to laſt) better bread may be baked, than in our common ovens, where the bread reſts upon the hearth, and the heat is continually decaying. Not to mention this, I ſay, phyſiology can enable us to confer a very grateful taſte on very many of the things we eat, barely by a ſkilful and moderate untying and exciting the formerly clogged ſpirits, and other ſapid parts contained in them. It can teach us to make better bread than is commonly eaten. And by diſcovering to us a better art of cookery, than *Apicius* and his ſucceſſors have left us, and by ſubſtituting innocently ſapid things, inſtead of thoſe unwholeſome ones, their delicioufneſs endears to men; it can teach us to gratify men's palates, without offending their healths: and in preſerving of freſh meats, fruit, *&c.* beyond their wonted ſeaſons of duration, the naturaliſt's ſkill may perform much more than you will readily believe.

Of preſerving biſket from putrefaction.

AND yet to incline you not to be too diffident in this particular, let me inform you, that much hath been already performed, as to the preſervation of aliments, even by thoſe, that have not troubled themſelves to make philoſophical inquiries after the cauſes and remedies of putrefaction in bodies, but only have been taught by obvious and daily obſervations, that the air doth much contribute to the corruption of ſome bodies, and the excluſion of the air to the hindering it. I remember, the inquiſitive and learned Mr. *Boreel* aſſured me ſome while ſince, that he had in his country, *Holland*, eaten biſket, that was yet good, after it had been carried from *Amſterdam* to the *Eaſt Indies*, and brought back thence again, (in which voyage, between two and three years are wont to be ſpent.) And to confirm my conjecture of the way of preſerving this bread ſo long, he told me, that the curious merchant, whoſe it was, uſed no other art, than the ſtowing his biſket, well baked, in caſks exactly calked; and beſides carefully lined with tin, for the more perfect excluſion of the air: adding, that to the ſame end the biſkets were ſo placed, as to leave as little room as poſſibly might be in the caſk; which alſo was not opened, but in caſe of abſolute neceſſity, and then preſently and carefully cloſed again.

Of preſerving fruits.

I MAY elſewhere tell you of an eminent naturaliſt, a friend of yours and mine, that hath a ſtrange way of preſerving fruits, whereby even gooſberries have been kept for many months, without the addition of ſugar, ſalt, or other tangible bodies: but all that I dare tell you, is, that he aſſures me, his ſecret conſiſts in a new and artificial way of keeping them from the air.

Of preſerving meats waſted, for long voyages.

BUT it ſeems more difficult, as well as more uſeful, to be able to preſerve meat long without ſalt; for it is ſufficiently known to navigators, how frequently, in long voyages, the ſcurvy, and other diſeaſes, are contracted by the want of freſh meat, and the neceſſity of feeding conſtantly upon none but ſtrongly powdered fleſh, or ſalted fiſh: and therefore, he is much to be commended, that hath firſt deviſed the way to keep fleſh ſweet, without the help of thoſe fretting ſalts men are wont to uſe to make it keep. This way is not unknown to ſome ingenious perſons in *London*. One of the moſt noted of whom, upon my conjecturing, how it may be performed, confeſſed to me, that I had hit upon the way in general. But the moſt ſatisfactory account I could get of it was from an Engliſhman, that lately practiſed phyſick in the *Eaſt Indies*, who, finding I was no ſtranger to what I aſked him about, told me freely, that he had ſeen both goat's-fleſh, and hen's, ſo well preſerved by this way, that though it were put up in the *Eaſt-Indies* a while before he came thence, yet he eat of it, and found it good and wholeſome between the Iſlands of *Cape Verd* (as the ſeamen call them) and *England*; ſo that this meat continued ſweet above ſix months, notwithſtanding the heat and cloſeneſs of the ſhip, the exceſſive heat they met with, in their paſſage under the line, and conſequently through the torrid zone; and that the way was only this, that the meat being well roaſted, and cut in pieces, was carefully and conveniently ranged in a very cloſe caſk, into which, afterwards, there was poured as much butter melted, ſkimmed, and decanted from the groſſer and ranker parts, as would fill up all the intervals left between the ſeveral pieces of fleſh, and ſwim about them all, and thereby keep out the air from approaching them; and then the caſk being exactly cloſed, was ſtowed up in a convenient place in the ſhip, and kept unopened till the meat was to be eaten. And it muſt not be omitted, that the relator, and others, that had the care of making proviſion for the voyage, were fain, inſtead of butter made of cow's-milk (which could not be had, where they took in their lading) to make uſe of that made of goat's, or ewe's-milk, which is not (as the Indians make it) ſo good, and to whoſe rankneſs he aſcribed that, which he had obſerved in ſome of the meat buried in it, which he thought might have been preſerved *longer* and *better taſted* (for *wholeſome* and *incorrupt* he ſaid it was) in our European butter; whoſe power to preſerve meat buried in it, after due coction, hath been confirmed to me upon their own obſervation, by an experienced officer of the Engliſh fleet, that had the overſight of the proviſions, and by others, that had opportunity to obſerve it.

Of preſerving raw meats.

BUT how much the naturaliſts ſkill may advance the dietetical part of phyſick, by enabling men to make aliments much laſtinger than naturally they are, I muſt not here labour to convince you by other inſtances, that I may not anticipate what we have elſewhere to acquaint you with, from other men's experiments, and our own, about the conſervation of bodies. Only I ſhall at preſent tell you in general, that I hope there will be ways found out to preſerve even raw fleſh it ſelf (for of the keeping of

roaſted,

Salting neats-tongues with ſalt-petre.

Of preſerving fleſh in ſpirit of wine.

roaſted, we have juſt now given you an inſtance) with things, that do not ſo much fret it, nor give it ſo corroſive a quality, when eaten, as our common ſalt doth. For not to mention what ſeveral curious perſons have practiſed, of ſalting neats-tongues with ſalt-petre, which, though done only to make them look red, ſhews, that a body, not corroſive like common ſalt, may preſerve fleſh; I have, for trial ſake, kept an entire puppy of a pretty bigneſs, untainted for many weeks, (and that in the midſt of ſummer;) and that without flaying, drying (by fire, or otherwiſe) or ſo much as exenterating him, or cleanſing him, or doing any thing towards the preſerving of him, ſave the keeping him immerſed in a well-ſtopt veſſel, under ſpirit of wine, (from whoſe taſte, I preſume, meat may be eaſily freed by water;) and there ſeemed ſmall cauſe to doubt, that the only thing, that hindred me from keeping him much longer, was the want of time to purſue the experiment, and take notice of its ſucceſs. For I remember, I have the ſame way kept a ſoft ſubſtance, taken raw from an ox or cow, for many months (if I miſtake not, eighteen or twenty) and found no putrefaction or ill ſcent in the immerſed ſubſtance; which, for aught I know, might have been preſerved divers years together the ſame way, or at leaſt, by an eaſy improvement of this method, of which, I lately intimated, I intend you hereafter an account.

Of conſerving by ſugar, and making ſugar of other concretes beſides the cane.

AND I ſhall further add on this occaſion, that if we reflect upon ſugar, which is (at leaſt in theſe weſtern regions) but an almoſt recent diſcovery, and conſider how many bodies are with it, by confectioners and others, not only preſerved, but rendered exceeding grateful to the taſte; that ſingle inſtance may ſuffice to make us think it probable, that expedients yet unthought of may, by an inſight into nature, be found out, for the preſervation of bodies: eſpecially, if our ingenious friend Mr. *W.* would ſhew us, how out of divers other concretes, beſides the ſugar-cane, a ſubſtance not unlike ſugar (though of different taſte, according to the nature of the vegetable, that affords it) may, by a peculiar induſtry, be prepared. Which, that you may not think unfeazable, let me mention to you (for perhaps he hath not yet taken notice of it) what even Indians have done of this nature. And firſt, let me inform you of what we are told by *Linſchoten*[*] concerning that drink, which in the *Eaſt-Indies* they call *ſura*, and made of the liquor dropping from the bloſſoms, that they cut away from the Indian palm-tree, which bears the coco-nut. For this *ſura*, he tells us, that amongſt other things, they make ſugar (which is called *jagra)* which is made by boiling that liquor, and ſetting it in the ſun, where it congeals to ſugar.

AND though I muſt not conceal from you, that our author adds, that it is not much eſteemed by reaſon of its brown colour, and for that (to uſe his words) they have ſo great quantity and abundance of white ſugar throughout all *India*; yet the latter reaſon, of the cheapneſs of *jagra*, ſeems to be the principal. For probably, if other ſugars were ſcarce, the melioration of this would be attempted; and it is very likely, that if a ſkilful naturaliſt had the ordering of that ſweet juice, of which the Indians make their *jagra*, he might very well make of it a ſugar of no ſmall uſe; and ſuch a ſugar would be very convenient in many caſes, and to many perſons, for its being different from the common ſugar, though it ſhould not be better. *Garcilaſſus* alſo (a much applauded writer concerning the *Weſt-Indies)* treating of the fruits of a Peruvian tree, called by ſome *Molle*, and by others Mulli, *Conficiunt* (ſaith he) *ex eo potum confricando blandè inter manus in aqua calida, donec dulcor omnis defricetur. Per-*

Apud Joh. de Laet. deſcr. Indiæ, l. 10. c. 3.

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[*] *Linſchoten*'s *Voyage*, chap. 56.——When they deſire to have no cocus, or fruit thereof, (namely, of the palm-tree) they cut the bloſſoms of the cocus away, and bind a round pot, with a narrow mouth (by them called *calao)* faſt to the tree, and then ſtop the ſame cloſe round about with pot-earth, ſo that neither wind nor air can enter in, or come forth; and in that ſort, the pot, in ſhort ſpace, is full of water, which they call *ſura*, and is very pleaſant drink, like ſweet whey, and ſomewhat better.

*colant hanc aquam, ſervantque dies tres quatuorve, donec ſubſideat*; *potus eſt limpidiſſimus, &c. Aqua eadem cocta convertitur in optimum mel.* ‘They make drink of that *Mulli*, rubbing it gently in their hands in hot water, until they have rubbed out all the ſweetneſs; they ſtrain that water, and keep it three or four days, until it ſettle, and then it becomes a very clear drink: the ſame water boiled turns into good honey.—Of this fruit boiled with water according to different manners is made wine, or good drink, or vinegar, or honey.’ And of the ſame plant *Petrus de Cieca* hath this confirming paſſage: *Ex hujus fructu cum aqua decocto, pro cocturæ modo fit aut vinum ſive potio admodum bona, aut acetum, aut mel.* And that there is a great affinity betwixt ſuch vegetable honies and ſugar, eſpecially if the juices be ordered with a deſign of turning them rather into ſugar than honey, you may eaſily gather from the next and more memorable inſtance, which we are to mention, and which is afforded to us by the diligent deſcriber of the Braſilian plants, who treating of the *Caraguata*, or *Erva Baboſa* (or, as ſome would have it, *Herba innominata caule portulacæ)* hath theſe words to our preſent purpoſe: *Porro* (ſaith he) *radendo novacula petroſa ſtolones, emanat ex concavitate liquor quidam tantâ copiâ, ut ex una ſolummodo planta (mirabile dictu) interdum* 50 *aut plures arobæ affluant, è quo liquore fit vinum, acetum, mel, & ſaccharum: liquor quippe perdulcis coquendo redditur multo ſuavior & ſpiſſior, ita ut tandem in ſaccharum congeleſcat:* ‘Then by cutting the ſhoot with a razor-blade made of a flint, there runs out of the cut a certain liquor in ſuch a quantity, that (which is wonderful) out of one ſingle plant, ſometimes fifty or more *arobæ* run out: from which liquor there is made wine, vinegar, honey, and ſugar. For the liquor, ſweet of itſelf, is by being boiled made much ſweeter and thicker, ſo that it at length kerns into honey.’

Apud eundem eodem loco.

SINCE the writing of theſe laſt lines, being viſited by an ancient virtuoſo, governor to a conſiderable colony in the northern *America*, and inquiring of him, among other particularities touching his country, ſomething in relation to the thoughts I had about the making of ſeveral kinds of ſugar; he aſſured me, upon his own experience, that there is in ſome parts of *New England* a kind of tree, ſo like our walnut-trees, that it is there ſo called; whoſe juice, that weeps out of its inciſion, *&c.* if it be permitted ſlowly to exhale away the ſuperfluous moiſture, doth congeal into a ſweet and ſaccharine ſubſtance: and the like was confirmed to me, upon his own knowledge, by the agent of the great and populous colony of the *Maſſachuſets*. And very lately demanding of a very eminent and ſkilful planter, why, living in a part of *America*, too cold to bear ſugar-canes, he did not try to make ſugar of that very ſweet liquor, which the ſtalks of maiz, by many called Indian-wheat, afford, when their juice is expreſſed, he promiſed me he would make trial of it; adding, that he ſhould do it very hopefully, becauſe that though he had never been ſolicitous to bring this juice into a ſaccharine form, yet having ſeveral times, for trial ſake, boiled it up to a ſyrup, and employed it to ſweeten tarts, and other things, the gueſts could not perceive, that they were otherwiſe ſweetened than with ſugar. And he further added, that both he and others had, in *New-England*, made ſuch a ſyrup with the juice of water-melons.

That the naturaliſt may find out new ways to inveſtigate the wholeſomeneſs or inſalubrity of aliments, proved by inſtances out of *Sanctorius*'s Medicina Statica.

NOR, *Pyrophilus*, is it only by teaching men to improve the wholeſomeneſs and taſtes of the aliments, or to keep them long uncorrupted, that the naturaliſt may contribute to the preſervation of man's health; for from the ingenious attempts of *Sanctorius*, in his *Medicina Statica*, we may be invited to hope, that there may be ways, as yet unthought of, to inveſtigate the wholeſomeneſs or inſalubrity of aliments: as he, by the weight of bodies, after having fed on ſuch and ſuch meats, finds, that ſwine's fleſh, melons, and ſome other things, that he names (in the third ſection) do much hinder inſenſible perſpiration, and conſequently are unwholſome; though, as I take it, it were not amiſs, that before ſuch obſervations be framed into general and eſtabliſhed aphoriſms, they were carefully made in bodies of differing ages, ſexes, and complexions, and with variety of circumſtances. But then again, preſuming theſe maxims to be judiciouſly framed, the ſame *Statica Medicina* makes it hopeful, that there may be unthought of methods found, whereby, by ways different from thoſe formerly uſed by phyſicians, a man may be much aſſiſted in the whole manner of ordering himſelf, ſo as to preſerve health, and to foreſee and prevent the approach of many diſtempers. And perhaps by ſuch unthought of ways, divers paradoxes of concernment to man's health may be made out, as the diligent *Sanctorius* to that obſervation propoſed in theſe words, *Semel aut bis in menſe facto exceſſu in cibo & potu, die ſequenti, licet ſenſibiliter non evacuet, minus ſolito perpendit annexus*, (in the following aphoriſm) addeth this important corollary: *Victus uniformis caret beneficio illorum, qui ſemel vel bis in menſe excedunt: expultrix enim à copia irritata excitat tantum perſpiratus, quantum ſine ſtatica nemo crederet:* 'If once in a month one eat or drink to exceſs, the day following, if he be weighed (though he hath ſuffered no ſenſible evacuation) yet then he will weigh lighter than is uſual. A conſtant diet wants the help of thoſe, that once or twice in a month do exceed: for the expulſive faculty being oppreſſed by too great repletion, ſtirs up ſo much of perſpiration, as without the ſtaticks no one would believe.' And indeed experience hath informed us, that the promoting or ſuppreſſing of inſenſible tranſpiration, by which, in a day, the body may diſcharge it ſelf of four or five pounds of excrementitious matter, hath a much greater power to advantage or prejudice health, than is wont to be taken notice of: ſo that we ſee, that the ſtaticks, which, though long known, were thought uſeleſs to phyſick, may afford ſeveral important directions in reference to the preſervation of man's health; to which there are likewiſe other ways, whereby the naturaliſt may contribute. For he may alſo deviſe means, whereby to judge of the qualities of aliments, eſpecially drinks, in their reſpective kinds, and likewiſe of the temperature of the air in this or that place aſſigned. We ſhall, in one of the following eſſays, deſcribe to you a ſmall ſlight inſtrument, by the help of which, one, that is acquainted with this or that particular ſort of wine, may give a near gueſs, whether it be embaſed with water or not. And whereas in moſt hot countries, where water being the common drink, it is of great concernment to man's health to be able to make a good eſtimate of the ſalubrity of it; and whereas phyſicians are wont to think water, *cæteris paribus*, the better and purer the lighter it is; this inſtrument preſently manifeſts, without any trouble of weighing in ſcales, what among any waters propoſed is the heavieſt, and which the lighteſt, and what difference there is of gravity betwixt them. And this diſparity may ſometimes be ſo great, that I remember ſome of our Engliſh navigators tell us, that upon bringing home a ſort of water out of *Africa* into *England*, they found by the common way of ponderation, the African water in the ſame bulk to be about four ounces in the pound lighter than the Engliſh. And as the thickneſs or lightneſs of waters may be thus preſently diſcerned by this hydroſtatical way, ſo it is poſſible, by ſome chymical experiments, eaſily enough to diſcover ſome other qualities, wherein waters, that are thought to be of the ſame nature, differ from each other: as we find, that very many pump-waters will not bear ſoap, as rain-waters, and the generality of ſpring-waters will do. Some water will not dye ſcarlet, or ſome other particular colour, becauſe they are ſecretly imbued with ſome kind of ſaline ſubſtance, that hath an operation it ſhould not have upon the ingredients imployed by the dyer. And I have ſometimes diſcovered a latent ſea-ſalt in water, where others ſuſpected no ſuch matter, by pouring into it a ſolution of good ſilver, made in aqua fortis. For as common ſalt, as well as the ſpirit of it, will

Sect. 3. Aph. 96.

The difference in tranſpiration betwixt the times after ordinary diet, and after exceſs, tried by the weighing of man's body.

Difference in the weight of waters.

That chymical experiments may diſcover other qualities in waters.

precipitate the metal out of ſuch a ſolution, in the form of a white calx; ſo it ſeemed rational to conceive, that in caſe the water I ſuſpected hath been imbued in its paſſage through the earth with a ſaline quality, though not conſpicuous enough to be taken notice of by the taſte, theſe ſaline corpuſcles diffuſed through the water would, though faintly, act their parts upon the diſſolved ſilver; and accordingly I found, that upon the mixtures of ſuch waters, and the metalline ſolution, there would immediately be produced a kind of whiteneſs (from ſome parts of the metal precipitated by the ſalt:) to avoid which, I have often been fain to uſe, in places where I met with ſuch waters, either rain-water, or that, which is freed from its common ſalt, by a ſlow diſtillation.

That the naturaliſt may diſcover the qualities of particular airs.

AND as for the temperature of the air, which is acknowledged to be of exceeding great conſequence, both as to health, and as to the prolongation of life, and which is poſſibly yet of greater moment to both than moſt men imagine, the ſkilful naturaliſt's ſagacity, if it were imployed to that purpoſe, might probably find divers ways of diſcovering the qualities, and conſequently the ſalubrity and unhealthfulneſs of the air in particular places. For the diligent *Sanctorius* (in the ſecond ſection of this *Medicina Statica)* teacheth us, how to eſtimate the healthfulneſs and inſalubrity of the air, by the weight of thoſe men's bodies, that live in it. And beſides this (nice) way, we ſee, that by the late invention of weather-glaſſes, it is eaſy to diſcern, which of two neighbouring houſes, and which of two rooms in the ſame houſe, is the colder. And I remember I have ſometimes bethought my ſelf of a ſlight way (to be mentioned in one of the following eſſays) by the help of which it is not hard to determine, in which of two places propoſed the air is, *cæteris paribus*, the dryer or the moiſter; and to give alſo ſome gueſs, both how much at the ſame time the air of one place exceeds that of the other, and how the temperature of the air changeth in the ſame place, at ſeveral times, either of thoſe qualities. And that the differing operations of ſeveral airs, upon certain ſorts of fleſh hung in them, upon ſome fading colours, upon bodies ſubject to gather ruſt, or to be tarniſhed, and, in a word, upon divers other ſubjects, may be more conſiderable, than men ſeem yet to have taken notice of, I ſhall think it ſufficient to have intimated in this place; being deſirous to haſten to the following eſſay, (wherewith I am to conclude, what I have to offer to you concerning phyſick) that I may have the more time to employ on it.

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# ESSAY V.

## *Preſenting ſome Particulars, wherein Natural Philoſophy may be uſeful to the Therapeutical part of Phyſick.*

The introduction.

AND now, *Pyrophilus*, the method, that we formerly preſcribed to our ſelves (a little after the beginning of the firſt eſſay) requires, that we conſider a while the Therapeutical part of phyſick, which is indeed that, whoſe improvement would be the moſt beneficial to mankind; and therefore I cannot here forbear to wiſh, that divers learned phyſicians were more concerned, than they ſeem to be, to advance the curative part of their profeſſion; without which, three at leaſt of the four others may prove indeed delightful and beneficial to the phyſician, but will be of very little uſe to the patient, whoſe relief is yet the principal end of phyſick; whereunto the phyſiological, pathological, and ſemeiotical parts of that art ought to be referred. There was a while ſince a witty doctor, who being aſked by an acquaintance of mine (himſelf an eminent phyſician, and who related this unto me) why he would not give ſuch a patient more generous remedies, ſeeing he grew ſo much worſe under the uſe of thoſe common languid ones, to which he had been confined, that he could not at the laſt but die with them in his mouth? briſkly anſwered, *Let him die if he will, ſo he die ſecundùm artem.* I hope there are very few of this man's temper; but it were to be wiſhed, that there were fewer learned men, that think a phyſician hath done enough, when he hath learnedly diſcourſed of the ſeat and nature of the diſeaſe, foretold the event of it, and methodically employed a company of ſafe, but languid remedies, which he had often before found almoſt as unable to cure the patient, as unlikely to kill him. For by ſuch an unprofitable way of proceeding, to which ſome lazy or opinionated practiſers of phyſick (I ſay ſome, for I mean not all) have, under pretence of its being ſafe, confined themſelves, they have rendred their whole profeſſion too obnoxious to the cavils of ſuch empiricks, as he, that (as the Lord *Verulam* reports) was wont to ſay, your *European* phyſicians are indeed learned men, but they know not the particular cures of diſeaſes; and (unreverently enough) to compare our phyſicians to biſhops, who had the keys of binding and looſing, and nothing elſe. Which brings into my mind what Monſieur *De Balzac* relates (in his witty French diſcourſe, of the court) of a phyſician of *Milan*, that he knew at *Padua*, who being content with a poſſeſſion of his ſcience, and, as he ſaid, the enjoyment of the truth, did not only not particularly enquire into the cure of diſeaſes, but boaſted, that he had killed a man with the faireſt method in the world: *E morto* (ſaid he) *canonicamante, è con tutti gli ordini.* And ſuch ſcoffs and ſtories are readily enough entertained by the major part of men, who ſend for phyſicians, not ſo much to know what ails them, as to be eaſed of it, and had not rather be methodically killed, than empirically cured. And it doth indeed a little leſſen even my eſteem of the great *Hippocrates*'s ſkill, to find mentioned in his writings ſo many of his patients, of whom he concludes, that they died. And I had much rather, that the phyſician of any friend of mine ſhould keep his patient by powerful medicines from dying, than tell me punctually when he ſhall die, or ſhew me in the opened carcaſs, why it may be ſuppoſed he lived no longer. But, *Pyrophilus*, my concern for mankind, and for the reputation of many excellent phyſicians, whoſe profeſſion ſuffers much by the want of either induſtry or charity, in ſuch as we have been ſpeaking of, hath diverted me longer than I thought from telling you, that I ſuppoſe it will be not very difficult to perſuade you, that this ſo uſeful therapeutical part of phyſick is alſo capable of being much improved by a knowing naturaliſt, eſpecially if he be an intelligent and expert chymiſt, as in this eſſay we will ſuppoſe him.

## CHAP. I.

That the naturaliſt may invent medicines chymically prepared, more pleaſant than the ordinary Galenical ones.

SOME Paracelſian would, perhaps, ſet forth, how much more eaſy to be taken chymically prepared medicines are wont to be, than thoſe loathſome and clogging Galenical potions, bolus's, &c. which are not only odious to the takers, but (which is much worſe) are to many ſo offenſive, that either the patients cannot get them down, or the incenſed ſtomach returns them by vomit, before they have ſtayed long enough in the body to do any more than diſtemper it. But I ſhall not much inſiſt on this, becauſe I think wholeſomeneſs to be much more conſiderable in a remedy than pleaſantneſs; though, I confeſs, I could wiſh, that phyſicians were more careful to keep patients from being almoſt as much troubled by phyſick, as by the diſeaſe; and to cure, according to the old preſcription, not only *citò* and *tutò*, but *jucunde* too: eſpecially conſidering, that, as we were ſaying, the loathſomeneſs of ſome medicines maketh the ſtomach reject them, before they can have performed their operations. And it is, I preſume, on this account as much as any other, that at *Oxford* learned and practical phyſicians, of your acquaintance, make very frequent uſe (on patients not feveriſh) of the reſin of jalap, barely drawn with ſpirit of wine; ſince, as we have tried, ſix, eight, or ten, or more grains, of this almoſt inſipid reſin, being cleanly prepared, according to art, and with a little gum tragacanth, and half its weight of powdered cinnamon, or ſome ſuch thing made up, may be taken in the morning in form of pills, inſtead of a potion; and is wont to evacuate plentifully enough, and yet gripe the patient much leſs than common purges. But, as I ſaid, I ſhall not inſiſt on this. I might better commend the uſefulneſs of chymiſtry to the therapeutical part of phyſick, from hence, that it is probable, that even emptying medicines may, by the ſpagyriſt's art, be ſo prepared, as not only to be leſs offenſive than common purges or vomits in the taking, but to be leſs painful in the working: as I have often obſerved, both in myſelf and others, that upon the taking of the clear, and not loathſome mineral waters of *Barnet*, though the medicine wrought with me ten or twelve times in a morning, yet it did neither pain me, or make me ſick, or diſorder me for the remaining part of the day, any thing near ſo much, as a common pill or potion, that had wrought but once or twice, would have done. And I ſhall elſewhere (God permitting) teach you a preparation of ſilver, whereof about three or four grains being made up (with any proper conſerve) into a little pill, is wont to make a copious evacuation of ſerum eſpecially (in bodies, that abound with it) without making the patient almoſt at all ſick, or griping him; inſomuch that I know ſome perſons, both phyſicians and others, with whom though this medicine work frequently in a day, and though (which is ſtranger) once taking of it will with ſome perſons work ſo for two or three, or more days ſucceſſively, yet they ſcruple not to go abroad and follow their buſineſs. And ſome, that take it, tell me, that when it works not with them, as for the moſt part, when it hath freed the body from ſuperfluous ſerum, it will ceaſe, and in ſome bodies will ſcarce purge at all, it neither puts them to pain, nor makes them ſick.

An inſtance in reſin of jalap, mineral waters and the Author's Pil. Lunares.

AND now I am ſpeaking of the painleſs ways of relieving the ſick, I ſhall add, that there is another way, whereby it is to be hoped, many patients may be reſcued from a great deal of pain; and that is, by finding out medicaments, that may in ſeveral diſtempers, that are thought to belong peculiarly to the chirurgeon's hand, excuſe the need of burning, cutting, trepanning, and other as well painful as terrible manual operations of chirurgery. *Helmont* tells us, that he knew a country-fellow, who cured all freſh wounds by a drink, made (as I remember) of burnt *Tilia*. I have informed you in another eſſay, of the cure I obſerved to be made of the exulcerated tumours of one ſick of the king's-evil, by the uſe of beer, altered by a little plant, that did not at all diſturb the taker. If we may believe *Helmont* and *Paracelſus*, *Præcipitatus Diaphoreticus*, taken at the mouth, doth cure, to uſe his own words, *Carcinoma*, *lupum*, *&* *quodlibet Æſthiomenum cacoëthes ulcus*, *ſive externum ſive internum*. And if there be any truth in what hath been affirmed to me by ſeveral eye-witneſſes, as well phyſicians as others, concerning the *weapon-ſalve*, and *powder of ſympathy*, we may well conclude, that nature may perform divers cures, for which the help of chirurgery is wont to be implored, with much leſs pain to the patient, than the chirurgeon is wont to put him to. I know a very ingenious man, that is

That the naturaliſt may find out inward medicines able to do chirurgical cures, proved by divers inſtances.

Helmont de febribus c. 14. See alſo the ſame author in Tract. quem vocat arcana Paracelſ. Et lib. de Febr. c. 14.

famous as well for his writings as for a remedy, wherewith he undertaketh to cure conſtantly the exulcerated cancers of women's breaſts, without any conſiderable pain: but having not yet had opportunity to make trial of that which I have lying by me, I ſhall only tell you he aſſures me, that this medicine is indolent, and mortifies the ulcerous parts as far as they are corrupted, without diſordering the party troubled with them; which I the leſs doubt becauſe, that (to add thus much on this occaſion) partly by the colour, *&c.* of this powder, and partly by his own confeſſion to me, it ſeems to be a dulcification of arſenick, firſt fixt with nitre, and then carefully freed from its corroſiveneſs, by very frequent diſtillations of freſh ſpirit of wine. I ſhall ere long have occaſion to teach you a drink, whereby exulcerated (but not cancerous) breaſts have been very happily cured. The learned *Bartholinus*, in his late *Obſervations*, mentions the cure of ſome hurts in the head, done without trepanning, in caſes, where that formidable and tedious operation is wont to be thought neceſſary. As for the terrible way of ſtopping the violent bleeding in great wounds, by ſearing the orifices of the veſſels with hot irons, it would be little needed, if we knew ſuch remedies, as that, which the inquiſitive *Petrus de Oſma*, in his *Curious Letter to Monardes from Peru*, mentions in this paſſage, which I find among his other obſervations: *Anno* (ſaith he) 1558, *in urbe D. Jacobi, quæ eſt in provincia Chyle, quidam Indi captivi ſuras ſibi amputârunt, & eas aſſas præ fame ederunt, & (quod mirabile dictu) cujuſdam plantæ folia vulneribus imponentes, illico ſanguinem ſiſtebant:* 'In the city of 'St. *James*, that is in the province of *Chyle*, certain captive Indians cut off the 'calves of their legs, and for hunger eat them, and (which is ſtrange) applying the 'leaves of a certain plant to their wounds, immediately they ſtanch the blood.' I knew a rich man, extremely corpulent, who having long had a ſtrange kind of fiſtula in his breaſt, and having travelled from one country to another, to conſult with the ableſt chirurgeons, was at length brought to that paſs, that at a conſultation they reſolved, by opening his breaſt, to try, if they could track the winding fiſtula, and ſave his life: and as the inſtruments, for this ſaid operation, lay upon the table, another famous chirurgeon caſually coming into the houſe, told the patient, that he had an art of curing fiſtulas without cutting them open, and without any conſiderable pain or trouble: whereupon the rich man offering him what he pleaſed for the cure, the chirurgeon quickly performed his promiſe, as the patient himſelf, who ſhewed me his breaſt, confeſſed to me, and that by the uſe of an almoſt indolent remedy, which he purchaſed of the chirurgeon, and which by his favour came to my hands: and that even very ill-conditioned fiſtulas may be cured without chirurgical operations, by medicines taken at the mouth, I ſhall ere long have occaſion to ſhew you by a notable example.

Apud monard. de ſimplic. medic. pag. 84.

Sir Walter Raleigh's cordial.

IN the mean time I ſhall add, that a man, whom I ſuppoſe you have often ſeen, having a while ſince received ſuch a kick of a horſe, as made the doctor and chirurgeon, that tended him, to conclude the part gangrenated, and the patient's condition, by the acceſſion of a violent fever, ſo deſperate, that they deſired to meddle with him no longer; a large doſe of Sir *Walter Raleigh*'s cordial, ſent him by an excellent lady you are nearly related to, not only freed him from his fever, and the delirium that attended it, but, to the wonder of all that obſerved it, reſtored the limb, that was concluded gangrenated, to its former ſoundneſs.

AND to bring credit to all theſe relations, I ſhall crown them with that memorable paſſage of *Gulielmus Piſo*, of as great things, that he ſaw done by the illiterate Indians themſelves: *Memini* (ſays he) *in caſtris membra militum globulis ſclopetorum icta, & jamjam ab Europæis chirurgis, tam Luſitanis quàm Batavis, amputanda, barbaros recentibus*

*recentibus gummi ſuccis & balſamis à ferro & igne liberâſſe, & feliciter reſtituiſſe. Oculatus itidem teſtis ſum in noſocomiis relicta ulcera & gangrenas ab illis, vel ſolo ſucco tabaci, curata:* 'I remember, that the limbs of ſoldiers wounded with gun-ſhot, to have 'been cut off by the advice of our European ſurgeons, both Dutch and Portugueſe, thoſe barbarous people by recent juices, gums and balſams to have freed 'them from knife and cauteries, and happily cured them. I alſo am an eye-'witneſs, that with the juice of tobacco alone, they have cured wounds given over by 'our ſurgeons.'

What great uſe the Indians make of the juice of tobacco.

BUT, *Pyrophilus*, that the making of divers helps to recovery, leſs diſtaſteful, or leſs painful to the patients, is not the only, nor perhaps the greateſt ſervice that chymiſtry may do him that attempts the cure of diſeaſes, I ſhall now endeavour to manifeſt in ſome particulars.

## CHAP. II.

That the ſearch of nature by chymiſtry in particular diſcovers the qualities of medicines.

AND firſt, the ſkilful naturaliſt, eſpecially if a good chymiſt, may much aſſiſt the phyſician to diſcover the qualities of medicines, whether *ſimple* or *compound*; that the experiments of the Spagyriſts may much contribute to the examining thoſe many things themſelves prepare, you will, I preſume, eaſily grant. That alſo divers mineral waters are of the nobler ſort of medicines, is ſufficiently confeſſed on all hands; and it is known too, that the induſtry of chymiſts hath produced ſome good directions towards the diſcovery of the minerals predominant in divers medicinable ſprings: but I am much miſtaken, if they have not left much for others to do, which may be eaſily done. And I ſcarce doubt, but that by the various ways, that might be propoſed, of trying what ſuch waters hold, and what ſaline or other qualities are predominant in them, not only the nature of thoſe medicinal waters, that are already uſed, might be more thoroughly underſtood; but undetected properties might in many others, that are now not taken notice of, be diſcovered; of ſome of which ways of examining mineral waters, I may elſewhere give you an intimation. And I have made ſeveral trials, that have, I confeſs, much inclined me to think, that the fault is rather in us, than either in nature or chymiſtry, that men do not, by the help of chymical experiments, diſcover more of the nature of divers medicaments, than hitherto they ſeem to have ſo much as aimed at. For though the abſtruſe endowments of ſpecificks will not, I fear, be learned in haſte, otherwiſe than by particular trials and obſervations; yet many ſimples have other qualities, which ſeem chiefly to reſide, though not in an elementary ſalt or ſulphur, yet in a part of the matter that ſeems of kin to a ſalt or ſulphur: ſuch as ſourneſs, ſaltneſs, a cauſtick or a healing faculty, abſterſiveneſs, and the like, upon whoſe account ſuch remedies ſeem chiefly to work in a multitude of caſes. And towards the inveſtigation of ſuch qualities, a chymiſt may oftentimes do much, without making all his trials in human bodies. But though, to illuſtrate this matter, I have ſometimes made ſeveral experiments, yet not having now my notes and obſervations at hand, I ſhall only mention a few things as they offer themſelves to my memory, reſerving the more diſtinct handling of this ſubject to another opportunity; and the rather, becauſe that till ſuch phænomena have been more diligently obſerved, and reduced to their diſtinct ſorts, I would have them looked upon but as hints to farther inquiries, not as ſufficient authority to ground general rules on.

THERE are ſome plants, whoſe juices, eſpecially when the ſuperfluous moiſture is exhaled or abſtracted, will, (ſome by the aſſiſtance of a gentle heat and filtration, and ſome, even of themſelves, in time which I remember, hath in ſome ſucculent plants amounted but to a very few hours) coagulate in part into a kind of ſalt, Of the nitro-tartareous ſalt in ſome vegetables.

which, if you pleaſe, you may call eſſential: and by this nitro-tartareous ſalt (as it ſeems to be) thoſe vegetables, whoſe juice affords it (ſuch as are, if I miſtake not their names, parietaria, borrage, bugloſs, *&c.*) may be diſcriminated from thoſe many others, from whence it is not (at leaſt by the ſame way) to be obtained. And poſſibly alſo theſe ſalts may, to a heedful ſurveyor of them, appear to differ enough from each other in ſhape, taſte, or other obvious qualities, to deſerve to be ſorted into differing kinds.

If likewiſe we compare the eſſential ſalts and ſpirits of theſe plants, with thoſe of ſcurvy-graſs, brook-lime, and other vegetables, that are counted antiſcorbutical, and abound in volatile and ſaline parts; and if we alſo examine other plants, by divers chymical operations, and obſerve not only their diſpoſedneſs or indiſpoſition to yield ſpirits or oils by fermentation, or without it; but thoſe other particulars, wherein they will appear to agree with, or differ from each other: there is little doubt but ſuch trials will make them diſcover, to a conſidering naturaliſt, much of their natures and properties, and eſpecially of ſuch as depend chiefly upon the plenty or paucity of the ſaline, unctuous, ſour, ſpirituous, lazy, tenacious or volatile parts.

Difference in operation between acid and alkalizate ſalts.

It may be alſo obſerved, that the infuſion or decoction of ſome plants, as of brazil, ſenna, *&c.* will be heightened into a reddiſh colour, by putting alkalizate ſalts, as of tartar, or of pot-aſhes, in the water that extracts their tinctures: whereas acid ſpirits, at leaſt ſome of them, will much impair, if not deſtroy their colour; as a little aqua fortis will immediately turn a red tincture of brazil, made in fair water, into a pale yellow: whereas, on the other ſide, I have obſerved, that a ſmall quantity of a ſtrong ſolution of pot-aſhes, dropt into an infuſion of red-roſe leaves, hath preſently turned it into a muddy colour, that ſeemed to partake of green and blue, but was dark and dirty; whereas a little aqua fortis, or good ſpirit of ſalt poured into the ſame ſimple ſolution, did immediately turn it into a fine red, and ſo it would do the muddy mixture lately mentioned, if it were put to it in a far greater quantity. I obſerved alſo, that with a very ſtrong (though clear and well-filtrated) lixivium of pot-aſhes, I could precipitate ſome part of the infuſion or decoction of red-roſes; which groſſer parts, when the mixture was filtrated through cap-paper, remained like a dirty coloured (though ſomewhat greeniſh) mud in the filtre; the fluid and finer part of the mixture paſſing through in the form of a liquor, high coloured, almoſt like muſcadine.

Of ink made by the decoction of divers aſtringent plants, with a little vitriol.

And on this occaſion, I remember, that as galls, a very ſtiptick vegetable excreſcence, will yield a decoction, with which, and copperas, the common ink is made; ſo divers other plants, of notably aſtringent parts, may be employed to the like uſe: for, by caſting vitriol into a decoction either of oaken bark, or red-roſes, or even a bare infuſion of either log-wood, or ſumach, to name now no other plants of the like nature, I have preſently made a mixture, that might make a ſhift to ſerve for writing-ink; but whether all ſtiptick plants, or they only, will with vitriol make an ink, I refer to farther inquiry. And as a ſolution of vitriol, and the decoction of the above-mentioned plants, do precipitate each other to make ink; ſo I remember I have tried, that by diſſolving the cryſtals of pure ſilver (made the common way with aqua fortis, or ſpirit of nitre) in a good quantity of fair water, that the liquor having no colour of its own, the colours it produceth in other bodies may be the better obſerved, I found, that I could with this liquor precipitate out of the infuſions alone of ſeveral vegetables ſubſtances differingly coloured, according to their reſpective diſpoſitions. And ſo I have found, with leſs coſt, that *ſaccharum Saturni*, which ſeems to be a kind of vitriol of lead, whilſt it lies diſſolved in the ſame ſpirit

Of ſome metalline precipitations.

of vinegar, which extracted it from the metal, being put to the bare infuſion of logwood, *lignum nephriticum*, red roſes (to name thoſe I now remember I made trial of) they will precipitate each other.

I MIGHT farther add, that I have tried, that ſulphureous ſalts, ſuch as oil of tartar, made *per deliquium*, being dropped into the expreſſed juices of divers vegetables, will in a moment turn them into a lovely green, though the vegetables were of colours differing from that, and from one another, (as I remember one of thoſe vegetables, in which I expected, and found that change, was of a fine carnation.) And I could tell you, that though it be diſputed, whether quick-lime have any ſalt diſſoluble in water, and of what ſort it is, the examen of that queſtion may be much furthered, by trying, as I have done, that the water of quick-lime, well made, will precipitate a ſolution of ſublimate made in fair water, and will preſently turn ſyrup of violets (which is blue) if well mixed with it, into a fair green. Experiments, I ſay, of this nature I might eaſily annex; but having already ſet down divers of them in what I have written concerning colours, I ſhall refer you thither: and now only add this obſervation, that the inveſtigation of divers medical qualities, even of animal ſubſtances, may be as much aſſiſted by the naturaliſt, eſpecially a chymiſt; as we elſewhere have by the diſtillation of the *calculus humanus* ſhewn, how much it differs from the ſtones, that are found in the earth. And if you take thoſe hard concretions, found at certain times in the heads of craw-fiſhes, that are wont to be called *lapides cancrorum*, and commit ſome of them to diſtillation, and infuſe ſome in vinegar, and others in old Rheniſh-wine, or ſtrong white-wine, you will probably diſcover ſomething of peculiar in the nature of this concrete, of which I may poſſibly elſewhere make farther mention to you. And not only ſo, but in ſome animal ſubſtances, you may, by fit experiments, diſcover notable changes to be made, and their qualities to be much heightened, when the eye ſcarce perceiveth any change at all, as I have purpoſely obſerved, in keeping urine in cloſe glaſſes, and a moderate heat for many weeks: for at the end of that time, the virtues, that depend upon its volatile ſalt, will be ſo heightened, that whereas upon putting ſpirit of ſalt to freſh urine, the two liquors readily and quietly mixed, dropping the ſame ſpirit upon digeſted urine, there would preſently enſue a hiſſing and ebullition, and the volatile and acid ſalts would, after a while, concoagulate into a third ſubſtance, ſomewhat of the nature of ſal-armoniack. And whereas the ſyrup of violets, formerly mentioned, being diſſolved in a little freſh urine, ſeemed to be but diluted thereby, a few drops of the fermented urine tempered with it did preſently turn into a deep green: and the ſame digeſted urine being dropped upon a ſolution of ſublimate made in fair water, preſently turned it white, by precipitating the diſſolved mercury. With what (various) ſucceſs we have likewiſe made upon ſome other parts of a human body, as well conſiſtent as fluid, ſome trials, analogous to what we have recited of urine, I may elſewhere, perchance, take notice to you: but of ſuch kind of obſervations I muſt give you but this hint at preſent.

That ſulphureous ſalts turn the expreſſed juices of vegetables into a green colour.

Of the diſtillation of the calculus humanus, and of the concretions, that are called lapides cancrorum.

The changes in animal ſubſtances made by fermentation only, particularly in urine.

Of the mixture of ſpirit of ſalt with digeſted urine.

## CHAP. III.

SECONDLY: by theſe and other ways of inveſtigating the medical qualities of bodies, the naturaliſt may be enabled to add much to the *materia medica*; and that two ſeveral ways.

That the ſearch of nature adds much to the materia medica,

FOR he may, by his ſeveral ways of trial, and by his chymical preparations diſcover, that divers bodies, eſpecially of a mineral nature, that are as yet not at all imployed by phyſicians, at leaſt internally, may be brought into uſe by them; and that others, that are naturally ſo dangerous, as to be uſed but in very few, and for

By imploying bodies hitherto not imployed.

the moſt part extreme caſes, may with ſafety be more freely employed. Some modern chymiſts (as particularly *Glauberus)* have of late prepared remedies not unuſeful out of zink or ſpelter. And I have already mentioned unto you an excellent medical uſe of ſilver, of which, prepared (as is there intimated) I have now this to add, that ſince I began to write of it to you, I met with a conſiderable perſon, who aſſures me, that ſhe her ſelf was by the uſe of it in a ſhort time, cured of the dropſy, though, by reaſon of her having a body very corpulent, and full of humours, ſhe have been thought more than ordinarily in danger of that ſtubborn diſeaſe. I have ſometimes wondered, that there hath been ſo little care taken by phyſicians, and even by chymiſts, to inveſtigate the qualities of mineral earths, and thoſe other reſembling bodies, that are, or may be plentifully enough digged up in moſt countries, though not the ſelf-ſame in all; for however men are pleaſed to paſs them ſlightly over, as if they were but elementary earth, a little ſtained, or otherwiſe lightly altered, I have ſeen great variety of them, that have been digged ſometimes within the compaſs of a little ſpot of ground: and the differences of divers of them, both as to colour, taſte, conſiſtence, and other qualities, have been too great, not to make me ſuſpect they were of very differing natures. And the true *bolus Armenus*, and the *terra Lemnia*, which is now brought us from the iſland, that gives it that name, (marked with a ſeal, which makes many call it *Terra ſigillata*, though that name be for the ſame reaſon applied to the *terra Sileſiaca*, and other medical earths) have been ſo eſteemed, both by antient and modern phyſicians, as well againſt malignant diſeaſes, and the plague itſelf, as againſt divers other diſtempers, that it is the more ſtrange, that (ſince the greateſt part of thoſe two earths, that are now brought into our countries, have not, as the more ſkilful complain, the true marks of the genuine earths, whoſe name they bear) phyſicians have not been more careful to try, whether their own countries could not furniſh them with the like, or as good, eſpecially in regard ſome of the few attempts of that nature, that have of late times been made, may give them as much incouragement. For, not to believe the boaſts of the Sileſian *Johannes Montanus* (who paſſeth for the inventor of the *Terra ſigillata Sileſiaca Strigonienſis)* in the writing he publiſhed of the virtues of it, that it is gold prepared and tranſmuted, by provident nature, into an admirable medicine; I find that learned phyſicians prefer it before the Lemnian earth, that is now brought from *Turkey*. And the experienced *Sennertus* gives it this commendation, *Experimentis* (ſaith he) *multis jam probatum eſt, ejus inſignes eſſe vires contra peſtem, febres malignas, venenatorum animalium morſus, diarrhœam, dyſenteriam:* ‘It is approved by many experiments, ‘that its virtues are excellent againſt the plague, malignant fevers, the bitings of ‘venemous creatures, the diarrhœa, and other fluxes.’ What he adds, that the chymiſts name it *axungia ſolis*, brings into my mind (what I ſhall hereafter have occaſion to mention more particularly to you) that I had once brought me a certain earth, by a gentleman, that digged it up in this, or ſome neighbouring country, which, though it ſeemed but a mineral earth, did really afford, to a very expert trier of metals of my acquaintance, a not deſpicable proportion of gold. They have alſo found in *Hungary* an earth, which they call *Bolus Tockavienſis*, which is affirmed by *Crato* (in *Sennertus)* to melt in the mouth like butter, and to have all the other proofs of the true *Bolus Armenus*, and therefore is, by that judicious phyſician, preferred before the modern bole-armony, even that, which was brought out of *Turkey* to the emperor himſelf. And he relates, not only its having ſucceeded very well againſt catarrhs, but his having experimentally found it of great efficacy in the plague, that reigned in his time at *Vienna*. To which I ſhall add, that a very learned and ſucceſsful Engliſh doctor now dead did ſome years ſince, during a great plague, that then

Of remedies newly prepared out of zink.

The cure of the dropſy by the pill lunaris.

Of the uſe of medicinal earths.

Epitome ſcientiæ naturalis, l. 2. c. 1.

Inſtances of gold and divers noble menſtruums drawn out of them.

then raged in the city, where he lived, find a vein of red earth, not very far from that town, and preſcribed it with very good ſucceſs in peſtilential fevers, as I was informed by an ingenious friend of his, that uſed to adminiſter it, and ſhewed me the place where he digged it.

I REMEMBER alſo, the experienced chymiſt *Johannes Agricola*, in his notes upon what *Poppius* delivers of *Terra ſigillata*, after having much commended the *Terra Sileſiaca* in divers diſeaſes, and equalled it to the beſt of *Turkey*, where he had travelled relates one ſtrange thing of it, with many circumſtances, and in a way, as if he ſpoke upon his own trial; namely, that the ſpirit of *Terra ſigillata*, by which I think he means the *Strigonienſis*, doth, though ſlowly, diſſolve gold as well as an *aqua regis*, and that into a red ſolution; whence in two or three days the gold will fall of it ſelf into a very fine and ſubtile powder. And the ſame author tells us, that he hath ſeen another earth digged at *Rheinſtran*, not far from *Weſterwaldt*, which was more inclinable to white than to yellow, which is preferable to the Sileſian, and gives more ſalt than it, and diſſolves ſilver better than other menſtruums; ſince, as he ſaith, the ſilver may thereby be eaſily made potable, and be prepared into a very uſeful medicine for the diſeaſes of the head. And for my part, I do not much wonder at the efficacy of theſe earths, when I conſider, that divers of them are probably imbued, as well as dyed, with mineral fumes, or tincted with mineral juices, wherein metal or minerals may lie, as the chymiſts ſpeak, *in ſolutis principiis*; in which form, having neither endured the fire, many of their uſefulleſt parts are more looſe and volatile, and divers of their virtues leſs locked up, and more diſpoſed to be communicative of themſelves, than they are wont to be in a more fixed or coagulated ſtate, or when they have loſt many of their finer parts by the violence of the fire.

Of medicines out of arſenick.

BESIDES, there are ſeveral mineral bodies, which, though perhaps they may not be of themſelves fit for the phyſician's uſe, may, by addition of ſome other convenient body, or by ſequeſtration of the more noxious parts, or by ſome ſuch other chymical preparation, as may alter the texture of ſuch minerals, be rendered fit to increaſe the *Materia Medica*. As I have known, that by a preparation of arſenick, with ſaltpetre, whereby ſome of the more volatile and noxious parts are driven away, and the remaining body ſomewhat fixed and corrected by the alkali of the nitre, it hath, by a farther dulcification with ſpirit of wine, or vinegar, been prepared into a kind of *balſamum fuliginis*, which wonderfully cured a phyſician of my acquaintance, as himſelf confeſſed to me, of dangerous venereal ulcers (divers of which penetrated even to the *meatus urinarius*) which had reduced him to great extremity.

And out of biſmutum.

Apud Schroderum in pharmacop. l. 3. c. 18.

Dr. I. C.

AND though biſmutum have not, that I know, till very lately, been uſed, unleſs outwardly, and eſpecially for a coſmetick (hereafter to be taught you,) yet the induſtrious chymiſt, *Samuel Cloſſeus*, by calcination, and addition of ſpirit of vinegar, and *cremor tartari*, makes two medicines of it, which he highly extols in the dropſy; and (to reſerve for another place, what I have tried upon tin-glaſs) a very expert chymiſt of my acquaintance doth, by preparing it with common ſublimate (carried up by which, I remember, it hath afforded a very prettily figured body) make it into a white powder, like *mercurius vitæ*, which he aſſures me he finds, in the doſe of a few grains, to purge very gently, without being at all, as *mercurius vitæ* is wont to prove violently enough, emetick.

Of the correction of poiſonous medicines.

2. BUT the naturaliſt may add to the *Materia Medica*, not only by inveſtigating the qualities of unheeded bodies, but alſo by gaining admittance for divers, that, though well enough known, are forborn to be uſed upon the account of their being of a poiſonous nature: for by digeſtion with powerful menſtruums, and ſome other ſkilful ways of preparation, the philoſophical ſpagyriſt may ſo correct divers noxious, nay

poiſonous concretes, unfit in their crude ſimplicity for the phyſicians uſe, at leaſt in any conſiderable quantity, as to make them uſeful and effectual remedies. *Helmont*, who, though frequently extravagant in his theory of phyſick, doth often make no bad eſtimate of the power of remedies, after having told us, that he adored and admired the clemency and wiſdom of God, for creating poiſons, gives this account of his ſo doing: *Nam venena* (ſaith he) *noluit nobis eſſe venena aut nocua. Nec enim mortem fecit, nec medicamentum exterminii in terra: ſed potius, ut parvo noſtri ſtudio mutarentur in grandia amoris ſui pignora, in uſuram mortalium, contra futurorum morborum ſævitiam. In illis nempe latitat ſubſidium, quod benigniora & familiaria ſimplicia recuſant alias. Ad majores & heroicos medentum uſus venena tam horrida ſervantur:* ‘ He made not venom ‘ to be our poiſon, for neither made he death nor any deletery medicament upon the ‘ earth; but ſo, that by a ſlight induſtry and endeavour of our own they might be ‘ turned into great pledges of his love, for the uſe of men againſt the cruelty of ‘ diſeaſes, which were in proceſs of time to ariſe. For in thoſe venoms is the help, ‘ that more benign and familiar ſimples cannot yield; and thoſe more frightful ‘ poiſons are yet preſerved in nature for the more great and heroick uſes of phy‑ ‘ ſicians.’ And though I would not forbid you, *Pyrophilus*, to think there is ſome hyperbole in the encomiums he here and elſewhere gives poiſonous ſimples; yet when I conſider, what great things are oftentimes performed by antimony, mercury, and opium, even in thoſe not over‑ſkilful ways of preparing them, that are divers of them vulgarly uſed by chymiſts, eſpecially when the preparations are (which doth ſeldom happen) rightly and faithfully made; I can ſcarce think it very unlikely, that thoſe active ſimples may, by a more ſkilful way of ordering and correcting them, be brought to afford us very noble remedies. And the ſame examples may in part prevent the main objection, that I can foreſee in this caſe, which is, that whatever corrects poiſons, muſt, with their virulency, deſtroy their activity; for the above‑named ſimples, though ſo prepared as to be medicines ſafe enough, have yet activity enough left them to let them be very operative, their energy being, by preparation, not only in part moderated, but in part ſo over‑ruled, as to work after a more innocent manner: As in *bezoardicum minerale*, ſkilfully prepared, (for it very ſeldom is ſo) the laxative and emetick virulency of the antimony is changed into a diaphoretick, reſolving, and deoppilative power; which probaby made the experienced *Riverius* (though counted a Galeniſt) ſo particularly recommend this medicine to phyſicians, which, if I be not miſtaken, may well be praiſed without being flattered. And *Helmont* ſupplies me with an eaſy experiment to our preſent purpoſe, by telling us, that aſarum, which when crude, doth, as is well known, provoke vomits, by a ſlight preparation (preſently to be mentioned) is ſo altered, that its virulency is changed, to uſe his expreſſion, *in deoppilans, diureticum tardarum febrium remedium*; which I the rather take notice of, becauſe I find, upon enquiry purpoſely made of ſome ingenious phyſicians of my acquaintance, that upon trial, they commend this preparation of *Helmont*'s, and confeſs, that by it the aſarum loſeth its emetick, and acquires a diuretical quality.

Helmont de pharmac. & diſpenſ. modern. num. 46.

Helmont. tract. ſupra allegato, num. 46. 47.

The preparation of aſarum turns it from being emetick to be notably diuretical.

Now that all other animal and vegetable poiſons may be corrected, without loſing their force with their virulency, is the affirmation of *Helmont* concerning *Paracelſus*'s and his *ſal circulatum (majus.)* And as for vegetables, he elſewhere tells us, that the *Lapis cancrorum* reſolved in *formam*, as he ſpeaks, *priſtinæ lactis, habet remedium contra inclementias multorum vegetabilium vi laxante infamium:* ‘ That the *lapis cancrorum* reſolved into the form of its firſt milk affords an antidote againſt the violence of many ‘ vegetables, that are infamous for their being over‑laxative.’ And I remember, that I knew two phyſicians, the one of which affirmed to me, his having ſeen trial made (by the

Helmont. p. 466.

Helmont. de Lithiaſi, l. 7. c. 32.

the help of a noble menſtruum) of what *Helmont* here teacheth, and found it true; the other, a perſon ſevere, and apt enough to diſſent from *Helmont*, aſſured me, that with the volatile ſalt of tartar, he had ſeen vegetable poiſons, and particularly napellus, ſo corrected by a light digeſtion with it, that it loſt all its poiſonous qualities: for proof of which, he freely offered me, to take himſelf as much of that fatal herb, as would kill three or four men, (but at that time, and in that place, I could not get any of the plant to make the experiment with.) And though I ſhall ſay nothing now concerning *Helmont*'s *ſal circulatum*, yet as to the volatilization of the ſalt of tartar, what I have ſeen ſcarce permits me to doubt, that it is poſſible. And if I could now clearly acquaint you with my reaſons, you would perchance not wonder to find me inclinable to think, that ſome ſuch methods (perhaps a menſtruum) may be found to correct poiſonous ſimples, without rendring them ineffectual. And though it muſt be ſome very powerful corrective, whether ſalt or liquor, that ſhall be able to correct any ſtore of differing poiſons; yet it is not irrational to think, that divers particular concretes may be prepared without any ſuch abſtruſe or general corrective, ſome by one way of handling it, and ſome by another. And in ſuch caſes, ſkill in the natures of particular bodies to be managed, or lucky hits, may ſupply the place of a meliorating diſſolvent; of which *Helmont* affords me a conſiderable inſtance, where he teacheth, in the place lately quoted, that the emetick property of aſarum may be taken away, and the plant turned into a noble diuretick, only by boiling it a while in common water. And whereas a wary man would be apt to ſuſpect, that this change is made but by the avolation of ſome ſubtile parts driven away by the heat of the boiling water, I find, that our author affirms, that though it be boiled with the like degree of fire, in wine, inſtead of water, it will not ſo loſe its violence. I have known white hellebore, opium, and ſome other noxious bodies, ſo prepared, as to be given not only harmleſly, but ſucceſsfully in ſuch quantities, as were they not ſkilfully corrected, would make them pernicious. We daily ſee, that the violent emetick and cathartick properties of antimony, may ſingly, by calcination with ſalt-petre, be deſtroyed. And (which is though a known, yet a notable experiment among chymiſts) mercury ſublimate may be deprived of its deadly corroſiveneſs, and prepared into a medicine inoffenſive even to children, by bare re-ſublimations with freſh mercury. And to give you one inſtance more of what the knowledge of the effects of chymical operations, and of the diſpoſition of a particular body, may enable a man to do, in changeing the pernicious nature of it; I ſhall add, that the violently vomitive flowers of antimony, which our wonted, though ſumptuous and ſpecious cordials are ſo unable to tame, I can ſhew you (which perhaps you will think ſtrange) ſo corrected, without the addition of any thing beſides heat and ſkill, that in a treble doſe, to that wherein they are wont to be furiouſly emetick, we have not found them to work otherwiſe than gently by ſweat. But ſome more particulars applicable to our preſent purpoſe, you will meet with by and by.

Inſtances in ſome of the ſecret menſtruums.

That the preparation of aſarum is only the boiling it in common water. Helm. in pharmacop. & diſpenſ. modern. n. 46, 47.

That the boiling in wine alte not its vi lence.

That the emetick and cathartick properties of antimony are deſtroyed by calcination with ſalt-petre, and mercury ſublimate be deprived of its corroſiveneſs by bare re-ſublimations with freſh mercury.

A ſtrange correction of the flowers of antimony.

## CHAP. IV.

THIRDLY, and now, *Pyrophilus*, that I am ſpeaking of the ſervice, that the naturaliſt may do phyſick, I muſt not pretermit, that he may aſſiſt the phyſician to make his cures leſs chargeable. For though to cure cheaply, be not properly, and in ſtrictneſs, any part of the end of the art of phyſick, which conſiders men's health, and not their purſe; yet it ought in charity, if not alſo in equity, to be the endeavour of the phyſician eſpecially when he dealeth with patients, that are not rich. For not to ſay any thing of fees of phyſicians, which in ſome places are

That the naturaliſt may aſſiſt the phyſician to make his cures leſs chargeable.

not very moderate, it is certain, that the bills of apothecaries, eſpecially in chronical diſeaſes, do often prove ſo chargeable, than even when the remedies ſucceed, by that time a poor patient is recovered, he is undone; and pays, for the prolongation of his life, that, which ſhould have been his livelihood. Whence it comes to paſs, that the more neceſſitous ſort of people are ever fain to languiſh unrelieved, for want of being able to purchaſe health at the apothecaries rate; or are deterred from applying themſelves to the phyſician, till their diſeaſes have taken too deep root to be eaſily, if at all, eradicated: and this oftentimes, not more through the fault of the apothecary, than of the doctor, who in his preſcriptions might, for the moſt part, eaſily direct things, that would be much more cheap, without being much leſs efficacious.

Now there are ſeveral particulars, wherein it may be hoped, that the naturaliſt may aſſiſt the charitable phyſician to leſſen the charge of his patients.

Inconveniences of ſtuffing recipes with a multitude of ingredients.

AND firſt, he may perſuade the phyſician to decline that more frequent than commendable cuſtom, of ſtuffing each *recipe* with a multitude of ingredients. It is not, that I approve the practice of ſome chymiſts, who too freely cenſure the compounding of ſimples; for I know, at ſome times, a complicated diſtemper requires in its remedy more qualities, than are, perhaps, to be met with in any of the known ſimples, that the phyſician hath at command (though one and the ſame ſimple may ſometimes anſwer divers indications; as a plant, that is hot and dry, may ſerve for a diſtemper that is cold and moiſt.) And I know too, that in ſome caſes to that ingredient, that is as it were the baſis of the medicine, other things muſt be added, either to correct its noxious qualities, or to allay its violence, or to ſerve for a vehicle to convey it to the part affected, or to make it eaſier to be taken by the patient, or to preſerve it from corruption, or for ſome ſuch like reaſon. But yet I think phyſicians may well be more ſparing, as to the number of the things preſcribed, than moſt of them uſe to be, both to ſave charges to their patients (upon which account it is, that I here mention it) and for other conſiderations. For the addition of needleſs ingredients adding to the bulk of the medicine, makes it but the more troubleſome to be taken, and the more apt to clog the ſtomach. And oftentimes the efficacy of the more uſeful ingredients, as well as their quantity in each doſe, is much abated, by their being yoked with thoſe, that are leſs appropriated, or leſs operative. Beſides, it ſeems a great impediment to the further diſcovery of the virtues of ſimples, to confound ſo many of them in compoſitions: for, in a mixture of a great number of ingredients, it is ſo hard to know, what is the operation of each, or any of them, that I fear there will ſcarce in a long time be any great progreſs made, in the diſcovery of the virtue of ſimple drugs, till they either be oftener imployed ſingly, or be but few of them imployed in one remedy. And beſides all this, whereas when one of theſe mixtures is adminiſtered, the phyſician expects but ſuch operations as are ſuitable to the quality, which he conceives will be predominant in the whole compound, ſeveral of the ingredients may have particular qualities that he dreams not of, which working upon a body, that the phyſician conſiders as ſubject only to the ſickneſs he endeavours to cure, may therein excite divers latent ſeeds of other diſtempers, and make new and unexpected commotions in the body. On which occaſion I remember, that whereas parſley is a very uſual ingredient of aperitive and diuretick decoctions and apozems, a famous and learned oculiſt tells me, he hath very often obſerved, that when he hath unawares, or for trial-ſake employed parſley, either inwardly, or even outwardly, to thoſe, that were troubled with great diſtempers in their eyes, he found the medicines, wherein that herb was but one ingredient among many, to cauſe either great pain or inflammation in the eyes. In confirmation of which, I ſhall add, that a while after having a ſlight diſtemper in my eyes, I one day found it upon a ſudden ſtrangely increaſed, without being able to imagine, whence theſe new ſymptoms proceeded, till at length, recalling to mind all I had done that day, I remembered, that at dinner I had eaten ſauce, wherein there was a pretty deal of parſley mixt with other things. And whereas in divers of theſe compoſitions ſome noxious ingredients are allowed, upon a ſuppoſition, that their ill qualities will be loſt, by their being, as it were, tempered with the reſt; though this may ſometime happen, yet it would be conſidered, that in treacle (eſpecially at one age of it) the opium doth not, conſidering the ſmall proportion of it to the reſt of the ingredients, loſe much, if any of its power, by being mingled with ſixty odd other drugs: which compoſition poſſibly owes much of its virtue to that little opium. And perhaps one reaſon, why thoſe that accuſtom themſelves to be ever and anon taking phyſick, though they often eſcape dangerous diſeaſes, (by preventing the accumulation of humours, and taking their ſickneſſes at the beginning) are yet almoſt ever troubled with one diſtemper or other, may be, that by the multiplicity of medicines they take into their bodies, divers things are excited to diſorder them, which otherwiſe would have lain quiet. I am not ignorant, that it may be alledged, that in compounded medicines, as treacle and mithridate, how many ſoever the ingredients be, they do ſo clog and temper one another's activity in the compoſition, that there reſults from them all one or more qualities fit for the phyſician's turn, and which is the thing he conſiders and makes uſe of. And I confeſs, that in ſome caſes this allegation doth not want its weight: for I conſider, that a decoction of galls, and a ſolution of copperas, though neither of them a-part be blackiſh, will, upon their mixture, turn to ink; and that when brimſtone, ſalt-petre, and coals, are well mingled together in a due proportion, they make gun-powder, a mixture, that hath qualities much more active than any of the ſever'd ingredients. But I fear, that when a multitude of ſimples are heaped together into one compound medicine, though there may reſult a new craſis, yet it is very hard for the phyſicians to know before-hand what that will be; and it may ſometimes prove rather hurtful than good, or at leaſt by the coalition, the virtues of the chief ingredients may be rather impaired than improved. As we ſee, that crude mercury, crude nitre, and crude ſalt, may be either of them ſafely enough taken into the body in a good quantity; whereas of ſublimate, conſiſting of thoſe three ingredients, a few grains may be rank poiſon. As for thoſe famed compoſitions of mithridate, treacle, and the like, though I cannot well, for the mentioned reaſons, commend the ſkill of thoſe, that firſt deviſed them; and though I think, that when one or two ſimples may anſwer the ſame indications, they may for the ſame reaſons be more ſafely employed; yet I would by no means diſcommend the uſe of thoſe mixtures, becauſe long experience hath manifeſted them to be good medicines in ſeveral caſes. But it is one thing, to employ one of theſe compoſitions, when trial hath evinced it to be a lucky one, and another thing to think it fit to rely on a huddle of ingredients, before any trial hath manifeſted what kind of compound they will conſtitute. And, in a word, though I had not the reſpect I have for *Matthiolus*, and other famous doctors, that deviſed the compoſitions, whereinto ingredients are thrown by ſcores, if not by hundreds, yet however I ſhould not reject an effectual remedy, becauſe I thought, that it proved ſo rather by chance, than any ſkill in the contriver: and I think a wiſe man may uſe a remedy, that ſcarce any but a fool would have deviſed.

ANOTHER thing, upon whoſe account the naturaliſt (whom we here ſuppoſe an expert chymiſt) may aſſiſt a phyſician to leſſen the expenſiveneſs of his preſcriptions, is by ſhewing, that in very many compoſitions, ſeveral of the ingredients, and oftentimes the moſt chargeable, whether they be proper or no for the diſeaſe, are unfit for the way of management preſcribed, and conſequently ought to be left out. I need not tell you, that ſince chymiſtry began to flouriſh amongſt us, very many of the medicines prepared in apothecaries ſhops, and commonly the moſt chargeable, are diſtilled waters, ſpirits, and other liquors: and he, that ſhall ſurvey the books and bills of phyſicians, ſhall find, that (very few perhaps excepted) the moſt uſual preſcription is to take ſuch and ſuch ingredients (for the moſt part numerous enough) and pouring on them either water or wine, if any liquor at all, to diſtil them *in balneo*, rarely in aſhes or ſand. But I confeſs, I have not without wonder, and ſomething of indignation, ſeen in the preſcriptions of phyſicians, otherwiſe eminently learned men, and even in the publick diſpenſatories, I know not how many things ordered to be diſtilled with others *in balneo*, which in that degree of heat will yield either nothing at all, as the fragments of precious ſtones, leaves of gold, prepared pearl, *&c.* or, if they do yield any thing, (for that hath not been yet, that I know of, evinced) do probably yield but a little nauſeous phlegm, or at leaſt ſome few looſe parts, far leſs efficacious than thoſe, that require a ſtronger heat to drive them up; ſuch as ſugar, raiſins, and other ſweet fruit, bread, hartſhorn, fleſh prepared by coction, *&c.* which, though wont to be thrown away with the *caput mortuum*, oftentimes there retain their priſtine texture and nature, or at leaſt are almoſt as much more conſiderable, than that which they yielded in diſtillation, as a boiled capon is, than the liquor, that ſticks to the cover of the pot. And though as to ſome of theſe ingredients it may be thought, that they may yield even *in balneo* ſome of their uſeful parts, yet this can, with any probability, be ſuppoſed but of ſome ſuch ingredients. And even as to them it is but ſuppoſed, that they may yield ſomething in ſo mild a heat; and how that ſomething will be qualified, is but preſumed; at leaſt, by the analogy of the experiments vulgarly made, there ſeems ſo ſmall cauſe to expect, that theſe more fixed ingredients will add half ſo much to the virtue of the medicines, as they will to the coſt; eſpecially ſince, though it could be proved, or were probable, that fixed ſubſtances may communicate their virtues to wine or water, yet it would not follow, that thoſe impregnated liquors, diſtilled *in balneo*, will carry thoſe virtues with them over the helm. All which I have more largely proved in another diſcourſe, where I ſhew both that the nobler parts of many ingredients, wont to be diſtilled *in balneo*, do commonly remain in the *caput mortuum*; and that it is very unſafe to conclude always the virtues of diſtilled liquors from thoſe of the concretes, that afforded them.

BUT there is another way of putting unfit ingredients into medicines, by confounding thoſe in one compoſition, which, though perhaps they might a-part be properly enough imployed, do, when mixed, deſtroy or lock up the virtues of one another; and of this fault even famous chymiſts themſelves are but too often guilty. I know not how many proceſſes I have met with, wherein ſaline ſubſtances, of contrary natures, are preſcribed to be mingled, as if becauſe they were all of them ſaline, they muſt be fit to be aſſociated; whereas it is evident to any man, that conſiders as well as imploys the operations of chymiſtry, that there are ſcarce any bodies in the world, betwixt which there is a greater contrariety, than betwixt acid ſalts; and as well thoſe that the chymiſts call volatile, as the ſpirits and ſalts of hartſhorn, blood, fleſh, and the like, as thoſe others, which are made of incineration, as ſalt of tartar, and of all burnt vegetables. So that oftentimes it happens, that by an unſkilful mixture two good ingredients are ſpoiled; as when vinegar, juice of lemons, juice of barberries, and the like, are preſcribed to be diſtilled with other ingredients, whereof the ſalt of wormwood or ſome other plant makes one: for then the acid and alcalizate ſalts working upon one another, grow more fixed, and yield *in balneo* but a phlegm; and ſo ſpirit of urine, which is highly volatile, and ſpirit of ſalt, which is alſo a diſtilled liquor, being mingled together, will, by their mutual operation, conſtitute a new

That acid and alcalizate ſalts being mixed, grow thereby more fixed, and yield in balneo but a phlegm.

thing,

The ſame is obſerved of the mixture of the ſpirit of urine (by it ſelf highly volatile, and ſpirit of ſalt.

thing, which in ſuch a heat as that of a bath, will yield a phlegm, leaving behind the nobler and active parts con-coagulated into a far more fixed ſubſtance, much of the nature of ſal-armoniack. And indeed where ſalts, eſpecially active ones, are made ingredients of mixtures, unleſs they be ſkilfully and judiciouſly compounded, it often happens, that they ſpoil one another, and degenerate into a new thing, if they do not alſo ſpoil the whole compoſition, and of divers uſeful ingredients compoſe one bad medicine.

## CHAP. V.

That the naturaliſt diſcovers the miſapplication and uſe of gems, and divers other coſtly ingredients.

ANOTHER way, by which the naturaliſt (ſkilled in chymiſtry) may help to leſſen the chargeableneſs of cures, is by ſhewing, that as to divers coſtly ingredients, wont to be employed in phyſick, there hath not yet been ſufficient proof given of their having any medical virtues at all, or that at leaſt as they are wont to be exhibited, either crude, or but ſlightly prepared in juleps, electuaries, *&c.* there is not any ſufficient evidence to perſuade us, that their efficacy is as much greater than that of many cheap ingredients, as their price is. I am not altogether of their mind, that abſolutely reject the internal uſe of leaf-gold, rubies, ſaphires, emeralds, and other gems, as things, that are unconquerable by the heat of the ſtomach: for as there are rich patients, that may, without much inconvenience, go to the price of the deareſt medicines; ſo I think the ſtomach acts not on medicines barely upon the account of its heat, but is endowed with a ſubtile diſſolvent (whence ſoever it hath it) by which it may perform divers things, not to be done by ſo languid a heat. And I have, with liquors of differing ſorts, eaſily drawn from vegetable ſubſtances, and perhaps unrectified, ſometimes diſſolved, and ſometimes drawn tinctures from gems, and that in the cold. But though for theſe and other conſiderations, I do not yet acquieſce in their reaſons, that laugh at the adminiſtration of crude gems, *&c.* as ridiculous; yet neither am I altogether of their adverſaries mind. For though I deny not the glaſs of antimony, which looketh like a kind of gem or ruby, will eaſily enough impart to liquors an emetick quality; yet I know too, there is great odds betwixt rubies and other gems (which will endure violent fires, and remain undiſſolved in divers ſtrongly corroſive liquors) and the glaſs of antimony, which is a body ſo far leſs compact and fixed, that ſpirit of vinegar it ſelf will work upon it, and a ſtrong fire will, in no long time, diſſipate it into ſmoke. But that, which I chiefly conſider on this occaſion, is, that it is one thing to make it *probable*, that it is *poſſible*, gold, rubies, ſapphires, *&c.* may be wrought upon by a human ſtomach; and another thing to ſhew both, that they *are wont* to be ſo, and that they *are* actually endowed with thoſe particular and ſpecifick virtues, that are aſcribed to them: nay, and (over and above) that theſe virtues are ſuch and ſo eminent, that they conſiderably ſurpaſs thoſe of cheaper ſimples. And I think, that in preſcriptions made for the poorer ſort of patients, a phyſician may well ſubſtitute cheaper ingredients in the place of theſe precious ones, whoſe virtues are not half ſo unqueſtionable as their dearneſs.

A difference between the fixedneſs of a gem, and of glaſs of antimony.

Concerning aurum potabile.

WHAT ſtrange excellency there may be in the *aurum potabile*, made by a true *adeptus*, or by a poſſeſſor of the liquor alkaheſt, I ſhall not now diſpute, not knowing what powerful and radical diſſolvents, the profound ſkill of ſuch men (if any ſuch there be) may furniſh them with to open the body of gold. But as for the attempts and practices of the generality of chymical phyſicians to make gold potable, beſides that their attempts to make their ſolutions volatile ſucceed ſo ſeldom, that even learned phyſicians, and chymiſts have pronounced the thing it ſelf unfeaſible; I confeſs, I ſhould much doubt, whether ſuch a potable gold would have the prodigious virtues its encomiaſts aſcribe to it, and expect from it. For I find not, that thoſe I have yet met with, deliver theſe ſtrange things, upon particular experiments duly made, but partly upon the authority of chymical books, many of which were never written by thoſe, whoſe names they bear. And others, I fear, commend *aurum potabile*, prepared after another-guiſe manner, than that we are now ſpeaking of, partly upon a preſumption, that if it be made volatile, it muſt be ſtrangely unlocked, and exalted to a mere ſpiritual nature; and partly upon rational conjectures (as they think them) drawn from the nobleneſs and preciouſneſs of gold. But for my part, though I have long ſince bethought my ſelf of a way, whereby I can, in a ſhort time, and a moderate fire, make my menſtruum bring over crude gold, in quantity ſufficient to make the liquor look, at the firſt or ſecond diſtillation, of a high golden colour; yet finding, that I could, by an eaſy art, quickly recover out of this volatile liquor, a corporal and malleable gold, I dare not brag, that my tincture (as an alchymiſt would call it) muſt needs do ſtrange feats, becauſe there is ſo noble a metal brought over in it. And if this or other preparations of *aurum potabile* prove good medicines, it would be farther inquired, whether the virtues may not in great part be rather attributed to the menſtruum, than the gold, (that requiring a very ſubtile liquor to volatilize it) or to the aſſociation of the corpuſcles of the gold, with the ſaline particles of the menſtruum, into a new concrete, differing enough from gold, though never ſo well opened. And as for the nobleneſs and preciouſneſs of this metal, that depends upon the eſtimation of men; whence in *America* the Indians, that abound with it, had not ſuch a great value for it. And in divers countries, at this day, it is poſtponed to iron, or to copper, and hath rather a political (if I may ſo ſpeak) than a natural virtue. Nor will it follow, that becauſe it is the fixedeſt and preciouſeſt of metals, that therefore it muſt be an admirable medicine: for we ſee, that diamonds, though they be the hardeſt of bodies, and very fixed ones, and in much greater eſteem, *cæteris paribus*, than gold, are yet ſo far from being accounted highly medicinal, that they are commonly (though perhaps not ſo deſervedly) reckoned among poiſons. But I ſee I have digreſſed; that, which I chiefly aimed at, being to inculcate, that whether gold and gems, and the like precious ingredients, may be good medicines or no, it were a good work to ſubſtitute cheap ones for the poorer ſort of patients; and that phyſicians are much to blame, who prize ſimples, as drugſters do, according as they are brought from remote countries, and are hard to come by; and cannot imagine, that what doth not coſt much money in the ſhops, can do much good in the body; as if God had made proviſion only for the rich, or thoſe people, that have commerce with *China* or the *Indies*: whereas indeed it may oftentimes happen, that what the chymiſts call their *caput mortuum*, and perhaps throw away as an uſeleſs *terra damnata*, may have as great virtues, as thoſe nobler parts, as they call them, which they have extracted from it; and a deſpiſed ſimple, nay even an excrement or an inſect, may in ſome caſes prove nobler remedies, than thoſe, that men call and think very noble bodies, not to ſay, than I know how many extracts and quinteſſences.

Examples of great medicines drawn from unpromiſing bodies.

Of the efficacy of unpromiſing medicines.

I SHALL not trouble you with many inſtances to prove this doctrine, having more fully diſcourſed of it, in one part of another treatiſe. But yet ſome inſtances, I ſuppoſe, you will here expect, and therefore I ſhall preſent you with a few of thoſe, that at preſent come into my mind.

WHEN the diſtillation of aqua fortis is finiſhed, the *caput mortuum*, as deſerving that name, is wont, by common diſtillers, to be thrown away; and I have ſeen whole heaps of it thrown by, as uſeleſs, by thoſe, that make aqua fortis in quantity to ſell it. And yet this deſpiſed ſubſtance doth, in common water it ſelf, yield a ſalt, which being only depurated by frequent ſolutions and filtrations, is that famous *Panacæa duplicata*, or *arcanum duplicatum*, which that great virtuoſo and knowing chymiſt, the

Duke of *Holſtein*, whoſe name it alſo beareth, thought worth purchaſing at the rate of five hundred dollars, and of which the prince's experienced phyſician thus writes to the induſtrious *Schroder*: *Mille experimentis ſalis hujus efficaciam aula noſtra comprobavit in melancholicis affectibus, febribus quibuſcunque continuis & intermittentibus, calculo, ſcorbuto, &c. Quin & ſomnum conciliaſſe præſertim in melancholicis non ſemel notavimus. Doſis à ſcrup.* 1. *ad ſcrup.* 2. *Libras aliquot quotannis abſumimus*: 'Our court hath 'tried the efficacy of this ſalt in a thouſand experiments in the diſeaſes of melancholy, 'in all fevers, continuous and intermittent, in the ſtone, ſcurvy, *&c.* Nay more, 'we have obſerved more than once, that it hath procured ſleep, eſpecially in perſons 'melancholy. The doſe is from one to two ſcruples; we uſe divers pounds of it in 'a year.' And another very ſkilful phyſician, that frequented that excellent prince's court, confirmed to me the ſame medicine's diuretick and deoppilative virtue. (But upon my own experience I can ſay little of it, having caſually loſt a great quantity I cauſed to be prepared to make trial with, before I had opportunity to imploy it.)

**The Duke of Holſtein's Panacæa duplicata is made of the vulgarly deſpiſed caput mortuum of aqua fortis.**

**Schroder. pharmacop. l. 3. c. 23**

BUT whereas in the *caput mortuum* of aqua fortis there remains pretty ſtore of eaſily ſoluble ſalt, in the *caput mortuum* of vitriol, when not only all the oil is forced away by the fire, but all the fixed ſalt is exactly ſeparated by water, there ſeems to remain nothing but a worthleſs *terra damnata*. And yet it is of this, that, as I ſhall teach you ere long, I make thoſe colcotharine flowers, which are poſſibly a nobler medicine than either the oil, the ſpirit, or the ſalt of vitriol.

**Flores Colcotharini are made of the caput mortuum of vitriol.**

As for the bezoar-ſtone, which is ſo often preſcribed by phyſicians, and ſo dearly paid for by patients, the experienced *Bontius*, a very competent witneſs in this caſe, (and whoſe account of the manner of its generation agrees the beſt, of any I have ſeen, with that I received from an intelligent perſon, that was imployed into *Perſia* by the late king) hath in one place a paſſage concerning it; and elſewhere writes ſuch things of the ſtone cut out of a man's bladder (though that, whilſt crude, be deſpiſed as a thing vile and uſeleſs in phyſick) as may be juſtly applicable to our preſent purpoſe: *Cæterum* (ſaith he, ſpeaking of the *Bezoar*-ſtone) *quantum ad hyperbolicas hujus lapidis virtutes & facultates portentoſas non tantas in eo mille experientiis edoctus inveni*: 'But for the exceeding and portentous virtues of the bezoar-ſtone I have found by a 'thouſand trials, that they are not ſo very great.' And elſewhere ſpeaking of thoſe contemptible and excrementitious ſtones, that are found in human bladders, *Nil porro* (ſaith he) *de his lapidibus addo, ne videar eos elevare, & lithotomos monere, ut vel cum periculo plures mortales ſecent. Hoc certè compertum habeo, lapidem in veſica hominis repertum, urinam & ſudores probè ciere, quod tempore ingentis illius peſtis, quæ anno* 1624 *&* 1625, *Leydam patriam meam, & reliquas Hollandiæ civitates miſerandum in modum vaſtabat, in penuria lapidis bezoartici nos exhibuiſſe memini, & ſudorificum (auſim dicere) melius & excellentius inveniſſe*, &c. 'I ſpeak no more of theſe ſtones, leſt I ſhould 'ſeem by my commendation of their virtues to provoke lithotomiſts to make diſſec'tions at any rate. This I have moſt certainly experienced, that the ſtone found in 'man's bladder doth well provoke urine and ſweat. And particularly in the time of 'that plague, which in the years 1624 and 1625 miſerably vexed ours, and all other the 'cities of *Holland*, for want of the bezoar-ſtone, I remember, I preſcribed this, and 'found it (let me tell you) a more great and excellent ſudorifick.'

**Bontius in c. 45. Garcia ab Orta. A compariſon between the bezoar-ſtone and the ſtone cut out of man's bladder.**

**Idem, c. 46. Garcia ab Orta.**

SOOT is generally looked upon as ſo vile a thing, that we are fain to hire men to carry it away; and yet, as I elſewhere ſhew, that it is a body of no ignoble nature, ſo I muſt here tell you, that it is no unuſeful one in phyſick. And not to mention, that *Riverius* commends it crude to the quantity of a drachm in pleuriſies; I have tried, with the ſpirit of it well drawn, ſome things, that make me look upon it as a conſiderable liquor. And I know by their own confeſſions, that ſome medicines,

**Medicines out of ſoot.**

even of eminent phyſicians, that paſs under other names, have the ſpirit of ſoot for their principal ingredient. I knew a not unlearned empirick, who was exceedingly cried up for the cures he did, eſpecially in difficult diſtempers of the brain, by a certain remedy, which he called ſometimes his *Aurum potabile* and ſometimes his *Panacæa*; and having obtained from this man, in exchange of a chymical ſecret of mine he was greedy of, the way of making this ſo celebrated medicine, I found, that the main thing in it was the ſpirit of ſoot, drawn after a ſomewhat unuſual, but not excellent manner; in which ſpirit, flowers of ſulphur were, by a certain way, brought to be diſſolved, and ſwim in little drops, that looked of a golden colour.

The uſe of horſe-dung.

An arcanum of ivy-berries.

You will eaſily grant, *Pyrophilus*, that there are not any medicines to be taken into the body more cheap and contemptible, than the excrements of men and horſes, and than inſects; and yet that even theſe want not conſiderable medical virtues, we elſewhere ſhew. And (not to meddle with ſuch naſty things, as the groſſer ſort of human excrements, though they, outwardly applied either in powder or otherwiſe, do ſometimes perform ſtrange things) the juice of horſe-dung, eſpecially of ſtone-horſes, being ſtrongly expreſſed (after the dung hath been a while ſteeped in ale, or ſome other convenient liquor, to facilitate the obtaining the juice, and to afford it a vehicle) doth oftentimes ſo powerfully relieve thoſe, that are troubled with the ſtoppage of urine, with wind, ſtitches, and even with obſtructions of the ſpleen and liver, that you, *Pyrophilus*, and I, know a great lady, who, though very neat, and very curious of her health, and wont to have the attendance of the ſkilfulleſt phyſicians, ſcruples not, upon occaſion, to uſe, as I have known her do, in ſilver veſſels, this homely remedy, and prefer it to divers rich cordials, and even to what ſome chymiſts are pleaſed to call *Eſſences* or *Elixirs*. And with the ſame remedy very many poor people were cured of the plague it ſelf, when it lately ſwept away ſo many thouſands in *Ireland* (and the doctors with the patients, as I was aſſured by a perſon who cured ſo many) as to invite men to ſecure themſelves that aſſiſtance, by refuſing the party the liberty to leave the town. But (to add that upon the by) this perſon, in exchange of a ſecret of mine, confeſſed to me, that the *arcanum*, which had cured ſuch numbers, and to which the juice of horſe-dung was a *ſuccedaneum*, was only a good doſe of the powder of fully ripe ivy-berries, which did uſually, as alſo the horſe-dung, work plentifully by ſweat, and which I preſently remembred to be one of thoſe few things, that *Helmont* commends againſt the plague.

Medicines out of man's body.

The medical virtues of man's urine, both inwardly given, and outwardly applied, would require rather a whole book, than a part of an eſſay, to enumerate and inſiſt on: but referring you to what an induſtrious chymiſt hath already collected touching that ſubject, I ſhall now only add, that I knew an ancient gentlewoman, who being almoſt hopeleſs to recover of divers chronical diſtempers (and ſome too of theſe abſtruſe enough) was at length adviſed, inſtead of more coſtly phyſick, to make her morning-draughts of her own water; by the uſe of which ſhe ſtrangely recovered, and is, for aught I know, ſtill well. And the ſame remedy is not diſdained by a perſon of great quality and beauty, that you know; and that too after ſhe had travelled as far as the *Spaw* for her health's ſake. And I remember on this occaſion, that paſſing once through one of the remoter parts of *England*, I was viſited by an empirick, a well-wiſher to chymiſtry, but a novice in it, who preſſing me to communicate to him ſome eaſy and cheap preparation, that he might make uſe of among the country-people; I directed him to diſtil with a gentle heat a ſpirit out of urine, putrified for ſix or ſeven weeks on a dung-hill, or ſome analogous heat, but in well-cloſed glaſſes, or other glazed veſſels; and having rectified this ſpirit once or twice, that it might be rich in volatile ſalt, to give ten, twenty, or thirty drops of it in a convenient liquor for the pleuriſy, for moſt kind of coughs, and divers other diſtempers, as a *ſuccedaneum* to the eſſence of harts-horn. And a while after, this empirick returned me great thanks for what I had taught him: and I found by him and others, that he had cured ſo many with it, eſpecially of pleuriſies (a diſeaſe frequent and dangerous enough in that country) that this ſlight and ſeemingly deſpicable remedy had already made him be cried up for a doctor, and was like to help him to a comfortable ſubſiſtence.

Medicines out of blood.

GREAT ſtore of healthy men's blood is wont to be thrown away, as altogether uſeleſs, by chirurgeons and barbers, that let men blood (as is uſual in the ſpring and fall) for prevention of diſeaſes; and yet from a man's blood ſkilfully prepared, though without addition of any thing, ſave ſpirit of wine to keep it at firſt from putrifying, may be eaſily obtained a ſpirit and volatile ſalt, that have much the ſame virtues with thoſe of the newly mentioned ſpirit of urine, but more noble (as far as I can gueſs) than either that, or even ſpirit of harts-horn; as having performed in conſumptions, aſthmas, and other obſtinate caſes, ſuch things, as I, as well as others, could not but admire. But in this place, mentioning human blood only *in tranſitu*, I ſhall pretermit what I have obſerved about the preparation of it; yet leaving you a liberty to call for my obſervations upon a medicine, which perhaps is nobler, than the moſt coſtly and elaborate chymical remedies, that are wont to be ſold in ſhops, and which hath been almoſt alone excepted out of the cenſure made by a learned modern writer, of the medicines found out by chymiſtry:

The great effects of millepedes in the ſtone.

I SHALL add but one inſtance more, of the efficacy, that may be found in the moſt obvious and abject creatures; and this inſtance is afforded me by thoſe vile inſects, commonly called in Engliſh, wood-lice, or ſows, and in Latin *millepedes*; which I have often both recommended to others, and taken my ſelf. What their virtue is againſt the ſtone, the world hath been informed by *Laurembergius*, who hath publiſhed a narrative, how by the uſe of them he was cured, even of the ſtone in the bladder; and he was invited to uſe them by credible information, that others had been cured of that diſeaſe, by the ſame remedy. And of late years in *England*, an empirick being much reſorted to, for the relief he gave in that tormenting ſickneſs, a phyſician, famous for his learned writings, wondring at what was done, was very curious (as himſelf afterwards told me) to find out the empirick's ſecret, and at length was ſo induſtrious as to diſcover, that it was a ſlight preparation of *millepedes*. But my having found them in my ſelf very diuretical and aperitive is not that, which chiefly recommends them to me; for I knew, and lived in the ſame houſe with a pious gentlewoman, much better ſkilled in phyſick, than her ſex promiſed, who having loſt the uſe of one eye by a cataract, and being threatned by the oculiſts with the ſpeedy loſs of the other, eſpecially in regard of her being very aged and corpulent, ſhe nevertheleſs did, for ſome years, to my wonder, imploy her eye to read and work with, without finding, as ſhe told me, any decay in it, or any increaſing danger of a ſuffuſion: and ſhe aſſured me, that her medicine was to bruiſe firſt five millepedes, then ten, then fifteen, then twenty, *&c.* (daily increaſing the number by five, till it had reached, if I miſtake not, fifty or ſixty) in white-wine (or ſmall-ale) and to drink upon an empty ſtomach the ſtrongly expreſſed liquor; and when I deſired to know, how ſhe came by this ſpecifick, ſhe anſwered me, that having made inquiries among all thoſe, both oculiſts and others, that ſhe thought might aſſiſt her againſt ſo ſad a diſtemper, ſhe was adviſed to the uſe of millepedes, by a woman, that not only much magnified their virtue in ſuch caſes as hers, but aſſured her (if I much miſremember not) that ſhe her ſelf had been cured by them, of no leſs than an incipient ſuffuſion in one or both of her eyes.

In ſuffuſions of the eyes.

And real cataracts.

[SINCE the writing of the former pages, relating what I newly told you to a very ingenious phyſician, he aſſures me, that being ſome years ſince in *Holland*, he there met with a woman, who was cured, as herſelf confeſſed to him, of a real cataract, by the juice of millepedes, beginning with that of three at a time, and ſo increaſing to nine at once, and then gradually leſſening the doſe by one inſect each day, till ſhe were come back to three at a time; after which, ſhe gradually increaſed the doſe as before. And he adds, that this woman was adviſed to this medicine by an empirick, that was ſaid to have performed divers cures with the ſame medicine.]

In ſore breaſts and fiſtulas.

[WHAT ſtrange things theſe ſame millepedes have done in the ſore, and even exulcerated, breaſts of women (provided they be not cancrous) though they be given without preparation only to the number of three at firſt, and ſo on to nine at once (which number may perhaps be uſefully increaſed) ſtamped with a little white-wine or beer, that the liquor ſtrained out may be drank in a draught of beer, morning and evening; during which time, linnen cloaths dipped in white-wine, and applied warm, are to be kept upon the breaſt; I may elſewhere have a fitter opportunity to relate. I ſhall now only ſubjoin, as a further proof of the great virtue, that may be even in vile and coſtleſs inſects, and that without any elaborate or chymical preparation, this memorable ſtory; that after all the trials I had made about theſe millepedes, I met with a young lady, who by divers ſtrangely winding and obſtinate fiſtulas, that had made themſelves orifices in many places of her body, was not only lamed, but ſo conſumed and weakned, that ſhe was ſcarce able to turn her ſelf in her bed; and this, notwithſtanding the utmoſt endeavours of the eminenteſt chirurgeons, both Engliſh and foreigners, that could be procured: but when both the hopes of her friends, and thoſe, that endeavoured to cure her, were loſt, ſhe was in a ſhort time not only freed from her fiſtulas, but recovered to a thriving condition of body, by the frequent uſe of an internal medicine, which, as both her parents, and the perſon, that taught it them, informed me, was only a drink (to be taken twice or thrice a day) made of a ſmall proportion of a couple of herbs, (very common, and not much more likely to do wonders in this caſe, than wormwood and mint;) and of three hundred of theſe millepedes well beaten (when their heads are pulled off) in a mortar, and tunned up with the herbs, and ſuſpended in four gallons of ſmall ale, during its fermentation. The wonderful efficacy of this medicine in this and many other caſes, which by occaſion of this cure were related to me, being almoſt wholly aſcribed to the millepedes, by the illuſtrious imparter of it, whoſe leave I have not yet, by naming him, to diſcloſe, that this is the ſecret he makes uſe of.]

## CHAP. VI.

That the naturaliſt diſcovers how much of the coſt and labour in making many chymical remedies may be ſpared.

ANOTHER way there is, whereby the naturaliſt may aſſiſt the phyſician to make the therapeutical part of phyſick leſs chargeable; and that is by ſhewing thoſe, that are wont to employ moſt chymical remedies, that much of the coſt and labour in many caſes might be ſpared. I am not altogether of their mind, that indiſcriminately cry down chymical preparations as exceſſively dear: for of many of thoſe that ſeem very dear, when bought by the pound or the ounce, a doſe may be cheap enough. As if, for inſtance, an ounce of precipitate of gold, and mercury, coſt ten times its weight of ſilver, under which rate I have bought it of honeſt men, that make it themſelves, yet that ounce containing 480 grains, (of which three or four may be a doſe) a taking of this dear powder may coſt far leſs than a doſe of many Galenical medicines, where the quantity, that is taken at once, makes up what is wanting in the coſtlineſs of the ingredients. But though this be the caſe of ſome chymical remedies, yet we muſt not deny, that many others are chargeable; and though perhaps not more ſo than many Galenical ones employed for the ſame purpoſes, yet if thoſe be dearer than they need be, that grievance ought to be redreſſed in chymical medicines, how juſtly ſoever the ſame thing may be imputed to Galenical ones.

A compariſon of chymical remedies with Galenical ones in point of cheapneſs.

Now there are two particulars, wherein the chymiſts, and thoſe phyſicians, that imitate them, are wont to be blameable in reference to this matter; the one their employing chymical preparations on all occaſions, even where ſimples or ſlight compoſitions might ſerve the turn; and the other is, their making many of their preparations more laborious, and conſequently more chargeable than needs.

Of the uſe and commendation of ſimples, even by the moſt able chymiſts.

As for the firſt of theſe: it is known there are divers chymiſts, and others, that practiſe phyſick, who ſo doat upon the productions of their furnaces, that they will ſcarce go about to cure a cut finger, with leſs than ſome ſpagyrical oil of balſam; and in ſlight diſtempers have recourſe to chymical, and perhaps to mineral remedies, which being, for the moſt part, ſuch as vehemently alter the body, eſpecially by heating and drying it, they do often more harm than good, when employed in caſes, that need not ſuch active medicines. And methinks thoſe, that practiſe, as if nature preſented us nothing worth the accepting, unleſs it be cooked and perfected by *Vulcan*, might conſider, that *Paracelſus* himſelf oftentimes employeth ſimples for the cure even of formidable diſeaſes. And though for particular reaſons I be inclinable enough to think, that ſuch ſearching and commanding remedies, as may be ſo much of kin to the univerſal medicine, as to cure great numbers of differing diſeaſes, will be hardly obtained without the help of chymical preparations, and thoſe perhaps of minerals: yet as to moſt particular diſeaſes, eſpecially when not yet arrived to a deplorable height, I am apt to think, that either ſimples, or cheap or unelaborate Galenical mixtures, may furniſh us with ſpecificks, that may perform much more than chymiſts are wont to think, and poſſibly be preferable to many of their coſtly magiſteries, quinteſſences, and elixirs. *Helmont* himſelf, a perſon more knowing and experienced in his art, than almoſt any of the chymiſts, ſcruples not to make this ingenious confeſſion: *Credo* (ſaith he) *ſimplicia in ſua ſimplicitate eſſe ſufficientia pro ſanatione omnium morborum:* ‘I believe ſimples in their own ſimplicity are ſufficient ‘for the curing of all diſeaſes.’ And elſewhere he truly affirms, that there may be ſometimes greater virtue in a ſimple, ſuch as nature affords it us, than in any thing that the fire can ſeparate from it. And certainly the ſpecifick properties of divers, if not moſt ſimples, are confounded and loſt by thoſe preparations, wherein that texture, which is the foundation of thoſe properties, is either deſtroyed by the fire, or changed by the taking away of ſome of the parts; or the adding of ſome other ſubſtance to it, with which compounded, it may conſtitute a new thing. The more judicious of the chymiſts themſelves do ſeveral of them now acknowledge, that the bare reducing of pearls to fine powder, affords a medicine much richer in the virtues of the pearls, than the magiſtery, prepared by diſſolving them in acid ſpirits, and precipitating them with oil of tartar, and afterwards ſcrupulouſly edulcorating them. And one may eaſily obſerve, that by making the magiſtery of harts-horn the ſame way, the virtues ſeem to be more locked up than they were in the crude horn; which may eaſily enough impart its virtue in the body, ſince fair water will reduce a good part of it into a jelly; whereas the magiſtery remains a fixed powder not eaſily diſſoluble, even in acid menſtruums; and, which thrown upon hot iron, will ſcarce ſend forth that ſtinking ſmoke, which argues the avolation of the ſaline and ſulphureous parts. I never knew any of the vulgar chymiſts eſſences or elixirs half ſo powerful a remedy, to ſtanch blood, as a ſlight mixture of two drachms of hyoſcyamum, or henbane ſeed, and the like weight of white poppy-ſeeds, beaten up with

Helmont. Pharma. & Diſpenſat. Nov. p. 458.

Powder of pearl more operative than magiſtery.

So crude hartſhorn, than magiſtery.

An excellent ſimple medicine to ſtanch blood.

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Another like medicine for ſpitting and vomiting of blood.

an ounce of conſerve of red-roſes, into a ſtiff electuary; with which, given in the quantity of a nutmeg, or wall-nut, I have ſnatched ſome, as it were, out of the jaws of death; and with which an eminent phyſician, now dead, affirmed, that he, and the inventor of the remedy, had very frequently cured profuſe bleedings at the noſe; and in women, at other parts beſides. Nor did I ever ſee, to give an inſtance in a reſembling diſeaſe, ſuch wonderful effects againſt ſpitting and vomiting of blood, of the moſt elaborate chymical preparations, as I have of a ſlight ſyrup, made only of a convenient quantity of fine ſugar, and the ſtrongly expreſſed juice of twelve handfuls of plantane leaves, and ſix ounces of freſh comfrey roots well beaten together: with which ſyrup, beſides what I have tried myſelf, two eminent phyſicians performed in that diſeaſe unuſual cures, though (for reaſons elſewhere mentioned) I forbear to name them, otherwiſe than by telling you, that one of them is that ingenious and friendly Dr. *T. C.* to whoſe ſkill both you and I owe ſo much.

BUT I conſider farther, that as oftentimes thoſe I am reaſoning with, make uſe of chymical remedies, when much more eaſily parable ones may ſuffice; ſo in divers caſes, where ſpagyrical medicines are proper enough, their preparations of them are more tedious and expenſive than is neceſſary. There are more than a few, who ſeldom preſcribe, and ſeldomer eſteem a chymical proceſs, that is to be perfected in leſs than many weeks; as if a chymical medicine, like an embryo, muſt needs be an abortive, if it be produced in leſs than ſo many months. And as if in preparations the virtue depended leſs on the ſkilfulneſs, than the elaborateneſs, they ſeem to eſtimate the efficacy of remedies by the time and pains requiſite to prepare them, and dare not think, that a medicine can quickly cure, that was not long a making; as indeed theirs (eſpecially where cohobations and digeſtions, till they have ſuch and ſuch effects upon the matter to be wrought on by them, are preſcribed) are many of them far more toilſome and tedious than thoſe, that have but read ſuch proceſſes, without working them, are apt to ſuſpect. And this is the humour of divers, not only as to thoſe ſtable medicines, that ought always to be found ready in apothecaries ſhops, but even as to thoſe, that are deſigned for particular caſes, and perhaps acute diſeaſes; in which emergencies, if a phyſician had no other remedies than thoſe he muſt make according to ſuch proceſſes, it would, I fear, too often happen, that before the medicine could be ready, the patient would either be paſt the need of it, or paſt the help of it. And that, which oftentimes increaſeth the tedioufneſs of chymical proceſſes, is the unſkilful preſcriptions of thoſe, that deviſe them. It is not unuſual in chymiſts writings to meet with proceſſes, wherein the matter to be prepared, is expoſed to I know not how many ſeveral ſucceſſive operations: but if you ſhould aſk, why ſuch a thing ſhould be, for inſtance, rather precipitated, than exhaled *ad ſiccitatem*; or why ſuch or ſuch an operation is to be uſed after ſuch another, rather than before it; nay, perhaps, if one ſhould demand, why ſome of thoſe operations ſhould be uſed at all, the deviſers of thoſe unſkilful proceſſes would poſſibly as ſoon be able to finiſh their operations, as to give a ſatisfactory anſwer. Nay, ſometimes they lengthen their proceſſes by operations, ſo injudiciouſly preſcribed, that they croſs one another; and the chymiſt vexeth himſelf, and the matter he works upon, to leave it at laſt no better, if not a worſe, medicine than he found it; of this we have already given an inſtance in the common magiſteries.

That many times chymiſts, by their tedious and injudicious preparations, alter the medicine, and make it worſe.

BUT I lately met with another example of it, in the writings of a famous, modern chymiſt; where, to purify the fixed ſalt of vegetables to the height, after I know not how many ſolutions, filtrations and coagulations (which alone would abundantly ſerve the turn) he preſcribes the diſſolving them in aqua fortis; after which, he ſaith, they will become very pure and cryſtalline, and not ſo eaſily reſoluble in the air: of which I make no doubt; for divers years before I met with his proceſs, I have, with the fixed ſalts of more than one kind of vegetable, by joining them with aqua fortis, and after a while exhaling the ſuperfluous moiſture, made good inflammable ſalt-petre; by which you may eaſily gueſs, how judiciouſly the ſolution in aqua fortis is preſcribed only as a farther depuration, and how fit ſuch authors are to be credited, when they aſcribe to theſe cryſtalline ſalts the ſeveral virtues (and thoſe improved too) of the reſpective vegetables, from which the alkalies were obtained. And indeed, as to thoſe exact depurations, which ſome chymiſts ſo ſtrictly require in all their preparations, though their proceſſes be oftentimes hereby made incredibly tedious, I will willingly allow, nay aſſert, that in ſome caſes, and eſpecially in the making of powerful menſtruums, which by their activeneſs and penetrancy are to unlock other bodies, chymiſts do rather err in making their depurations leſs exquiſite than they ſhould, than on the other hand. Yet in many other caſes, ſuch exact refining and ſubtilization of a remedy is not ſo neceſſary as they imagine; and ſometimes too may do more harm than good, by ſequeſtering thoſe parts of a ſimple, as *fæces*, which concurred with the finer parts to that determinate texture, whereon the ſpecifick virtues of it did principally depend: but of this, more elſewhere. And therefore I ſhall here preſent you with two or three inſtances, to ſhew you, that remedies, at leaſt as noble, as ſuch vulgar chymical ones, as are moſt tedious and coſtly, may be prepared in a ſhorter time, and cheap enough to be fit for the uſe of the poor.

So the diſſolving the ſalts of vegetables in aqua fortis, to make them pure and cryſtalline, alters their virtues, and makes them inflammable as ſalt-petre.

AND to comply, *Pyrophilus*, with your curioſity to know the preparations of thoſe chymical medicines, that I do the moſt familiarly imploy, the three following inſtances ſhall be of ſuch, namely, the *flores colchotharis*, the *balſamum ſulphuris craſſum*, and the *eſſentia cornu cervini*, that you may ſee what ſlight and eaſy preparations afford the remedies, whoſe effects you have ſo often heard of, if not alſo ſeen.

THE firſt of theſe is the ſame powder, which paſſeth under the name of *ens Veneris*; which appellation we gave it, not out of a belief, that it equals the virtues aſcribed by *Helmont*, to what he calls the true *ignis Veneris*, but partly to diſguiſe it a little, and partly upon the account of the occaſion, whereon it was firſt found out; which was, that an induſtrious chymiſt (whom you know) and I, chancing to look together upon that tract of *Helmont*'s which he calls *Butler*, and to compare it ſomewhat attentively with other paſſages of the ſame author, we both reſolved to try, whether a medicine, ſomewhat approaching to that he made in imitation of *Butler*'s ſtone, might not be eaſily made out of calcined vitriol: and though upon trials we found this medicine far ſhort of what *Helmont* aſcribes to his, yet finding it no ordinary one, we did, for the mineral's ſake it is made of, call it *ens primum Veneris*.

THE preparation, in ſhort, is this: Take good *Dantzick* vitriol (if you cannot get Hungarian or Goſlarian) and calcine it till the calx have attained a dark-red, or purpliſh colour; then, by the frequent affuſion of boiling, or at leaſt warm water, dulcify it exactly: and having freed it as well as you can, from the ſaline parts, dry it thoroughly, and after mix it exquiſitely, by grinding, or otherwiſe, with an equal weight of pure ſal armoniack, very finely powdered. Put this mixture into a glaſs retort, that may be but a third part filled with it, and ſubliming it in a ſand-furnace, by degrees of fire, for ten or twelve hours, towards the latter end increaſing the fire, till the bottom of the retort (if you can) be brought to be red-hot. That which is ſublimed muſt be taken out, and if it be not of a good yellow, but pale, (which

The preparation and virtues of ens Veneris.

uſually happens for want of an exact commiſtion of the ingredients) it may be returned to the reſidue, mingled better with it again, and ſublimed once more. The yellow or reddiſh ſublimate may be ſublimed a ſecond time, not from the *caput mortuum*, but by it ſelf; but if you re-ſublime it oftener, you may, though you will think that ſtrange, impair the colour and the ſublimate, inſtead of improving them. The doſe is from two or three grains to ten or twelve (in ſome bodies it may be increaſed to twenty or thirty, without danger) in diſtilled water, or ſmall-beer, or other convenient vehicles: it may be given at any time upon an empty ſtomach, but I moſt commonly give it at bed-time. It works, when it works ſenſibly, by ſweat, and ſomewhat by urine. That it is a potent ſpecifick for the rickets, I think I ſcarce need tell you, *Pyrophilus*, whoſe excellent mother and aunt, together with ſome phyſicians, to whom I alſo gave it ready prepared, have cured perhaps a hundred, or more, children, of that diſeaſe, divers of whom were looked upon, as in a deſperate condition. I give it alſo in fevers, and other diſtempers, to procure ſleep, which it uſually doth, where it is wanting. In the head-ach likewiſe, in which, if the diſeaſe be inveterate, the remedy muſt be long continued; with the like admonition it hath done wonders *in ſuppreſſione menſium obſtinata*. In the worms it hath ſometimes done ſtrange things; and for provoking of appetite, I remember not, that I have either taken or given it without ſucceſs. And though I ſeldom take (for I often give more) above two or three grains of it at a time, yet in that ſmall doſe it uſually proves diaphoretical to me the next morning.

BUT the experiments we have had of the ſeveral virtues and efficacy of this medicine, would be here too tedious to recite, and therefore I ſhall now paſs them by; though, if you require it, I ſhall not be backward to ſet you down, by way of obſervations, moſt of the caſes wherein I or my friends have given it, and of the principal cures that have been performed by it. In the mean time, becauſe this exalted colcothar, being given in ſo ſmall a doſe, may prove, if it be rightly and dexterouſly prepared, what *Helmont* ſaith of his imitation of *Butler*'s drif, *a medicine for the poor*, and yet requires more care, not to ſay ſkill, to prepare it well, than by the bare reading of the proceſs you will imagine; I ſhall, to gratify your charity, annex to the end of this eſſay (for to inſert them here would make too prolix a digreſſion) as many of the particulars relating to the preparation of it, as I can readily meet with among my looſe notes. And leſt you ſhould think me a mountebank for want of knowing in what ſenſe it is, that I commend this and the other particular medicines, I ſhall likewiſe, to thoſe obſervations, ſubjoin a declaration of my meaning in ſuch particulars, and of the ſenſe, wherein I deſire you ſhould underſtand what you meet with in the praiſe of remedies, either in this eſſay, or any other of my writings, which I hope it will be ſufficient, to give you this advertiſement of, once for all.

THE next medicine, I am to mention to you, is the *balſamum ſulphuris*, which being made but with groſs oils, drawn by expreſſion, may be called *craſſum*, to diſtinguiſh it from the common and thinner balſam of ſulphur, that is made with the diſtilled oil or ſpirit of turpentine.

The preparation and virtues of the balſamum ſulphuris craſſum.

THIS balſam is made in an hour or leſs, without a furnace, only by taking to one part of good flour of brimſtone, four or five times as much (in weight) of good expreſſed oil, either of olives, or nuts, or poppy ſeeds, and boiling the former in the latter, in a pipkin half filled with both, till it be perfectly diſſolved into a blood-red balſam. But as eaſy as this preparation ſeems (and indeed is) to them, that have often made it, it will not at firſt be ſo eaſy to make it right. For the fire, which ought to be of well kindled coals, muſt be kept pretty quick, and yet not over-quick, leſt the oil boil over, or do not well diſſolve the flower of ſulphur, but turn them with its ſelf into a clotted and almoſt liver-coloured maſs. And to avoid theſe inconveniences, and the aduſtion of the matter, ſpecial care muſt be had to keep it conſtantly ſtirring, not only whilſt the pot is over the fire, but after it is taken off, till it be quite cold. You may, if you think fit, diſſolve this ſimple balſam in chymical oil of aniſe-ſeeds, or any other eſſential oil, like to advance its efficacy in this or that particular diſtemper; but thoſe oils being generally very hot, I moſt commonly preſcribe the balſam without thoſe additions, eſpecially if long digeſtion have ſomewhat leſſened the offenſiveneſs of the ſmell, which though no peculiar fault of this preparation, being common to ſulphureous medicines, is yet the chief inconvenience of it. I will not reſolutely affirm, that this is the very *balſamum ſulphuris Rulandi*, of which that author relates ſuch wonderful things in his Centuries; but if it be not the ſame, it is ſo like it, and ſo good, that I doubt not but by peruſing thoſe Centuries, you may find divers uſes of it, that I have not made trial of. And in coughs, old ſtrains, bruiſes, aches, (and ſometimes the incipient fits of the gout itſelf) and eſpecially tumours, ſome of your friends can inform you, that it doth much greater things, than moſt men would expect from ſo ſlight and eaſy a preparation; and indeed greater than I have ſeen done by very coſtly and commended balſams and ointments, ſold in apothecaries ſhops. And in thoſe obſervations, I lately told you, you might command, you will find, that this balſam outwardly applied hath cured ſuch obſtinate tumours, as men either knew not what to make of, or what to do with them, of which ſkilful phyſicians, to whom I gave it to make trial of in difficult caſes, can bear me witneſs; though it ought ſufficiently to endear this balſam to us both, that it was the means of reſcuing your fair and virtuous ſiſter *F.* from a dangerous conſumption. In outward application it is to be well warmed, and to be chafed into the part affected, which ſhould be afterwards kept very warm, or elſe lint dipt in it may be kept upon the place. Inwardly ſome drops of it may be given at any time, when the ſtomach is not full; either rolled up with ſugar, or mingled with any convenient vehicle. But as for the particulars that concern the preparation of this balſam, you will find thoſe I can readily meet with among my looſe papers, annexed, with the notes concerning *ens Veneris*, to the end of this eſſay.

The preparation and virtues of eſſence of hartshorn.

AND therefore I ſhall now proceed to mention the third medicine, which you have often heard of, under the name of eſſence of hartſhorn; but which is indeed only the ſimple, but well purified and dephlegmed ſpirit of it. And though men are pleaſed to imagine, by the effects this remedy often produces, that I have ſome myſterious or elaborate way of preparing it, yet, to deal ingenuouſly with you, the chief thing I have done to bring it into credit, is the teaching ſome phyſicians and apothecaries a ſafe and eaſy way of making it. For whereas before, thoſe, that went about to diſtil it, commonly uſed, as the apothecaries are wont to do in what they make of the ſame matter, ſhavings or raſpings of hartſhorn, and diſtilled it with a ſtrong and naked fire, the fugitive and ſubtile ſpirits were wont to come over in that plenty, and with that impetuoſity, as to break the glaſſes to pieces, whereby apothecaries, and even chymiſts were diſcouraged from drawing the ſpirit; and they not having it in their ſhops, its virtues remained unknown. Whereupon, conſidering, that if it were only broken on an anvil into pieces of about the bigneſs of one's little finger, beſides that this way of comminution would be far leſs chargeable than raſping, the fumes would not be driven out ſo faſt: and conſidering too, that a violent fire was requiſite, not to diſtil the ſubtile ſpirit, but to drive over the groſs and heavy oil; I thought it was needleſs to take pains to force that over, which not being (that I obſerved) uſed in phyſick, would coſt me further pains to ſeparate it again. And therefore, trying to diſtil hartſhorn, in naked retorts, placed but in ſand, I found I could diſtil two or three pound at a time, and obtain from each of them, almoſt, if not quite, all the ſpirits and volatile ſalt, which I afterwards ſeparated from the reddiſh and lighter oil, and freed them from phlegm and feculencies by a couple of rectifications, made in tall glaſſes, and with very gentle heats, (commonly of a lamp-furnace.) The doſe may be from eight or ten drops of the ſpirit, or grains of the ſalt, to ſix times the quantity of either, in warm beer, or any vehicle that is not acid, except milk. Finding it to be a medicine of an attenuating, reſolving, and diaphoretical nature, and one that much reſiſts malignity, putrefaction, and acid humours, (whence being mingled with ſpirit of vinegar, and the like ſour juices, it deſtroys their acidity) I direct it (*præmiſſis univerſalibus*) in fevers, coughs, pleuriſies, obſtructions of the ſpleen, liver, or womb, and principally in affections of the brain, as ſtoppages of the head, feveriſh deliriums, and even *in phrenetide*. And ſince I wrote a good part of this eſſay, I had an experiment of it in a child, who being, by many violent convulſion-fits, reduced to a deſperate condition, was recovered by one doſe of five or ſix drops of this ſpirit that I ſent it. It is true, that I have another medicine, that is more elaborate and coſtly, and more properly bears the name of *eſſentia cornu cervi*, which I more value than this: but I cannot communicate that, without prejudicing a third perſon, and an excellent chymiſt, who makes great advantage of it. But this I can tell you, that moſt of the cures, for which my preparation of hartſhorn hath had the good fortune to be eſteemed, have been performed with the above deſcribed ſimple ſpirit and ſalt, with which ſome ſkilful phyſicians and other ingenious perſons who had it from me, have within theſe few years ſaved ſo many lives, that I am inclined to think, I have done no uſeleſs piece of ſervice, in bringing ſo happy a medicine into requeſt, eſpecially with thoſe, that have ſkill and opportunity to make better uſe of it than I. But, *Pyrophilus*, I find I have detained you ſo long with ſo prolix a mention of the three above deſcribed remedies, that I ſhould think it requiſite to make you a ſolemn apology; but that I hope your charity will as well invite you to pardon the fault, as mine induced me to commit it.

## CHAP. VII.

That mechanicks and other experimental learning may teach how to leſſen the charge of cures, by making more convenient furnaces, demonſtrated in divers particulars.

A FOURTH way of leſſening the charges of cures may be this; that whereas the dearneſs of very many medicines proceeds from the chargeableneſs of thoſe chymical operations, whereby they are wont to be prepared, it is to be hoped, that a greater meaſure of ſkill in phyſiology, and other experimental learning, will ſuggeſt cheaper and better ways of doing many things in chymiſtry, than are, as yet, uſually practiſed.

AND thoſe thrifty expedients, I conceive, may be of ſeveral kinds, of which I ſhall at preſent mention, and that but tranſiently, three or four.

AND firſt, I doubt not but chymiſts may be taught to make better furnaces, for ſeveral purpoſes, than thoſe, that have been hitherto moſt uſed among them. For profeſſed chymiſts having been for the moſt part unacquainted enough with many other parts of learning, and particularly with the mechanicks, their contrivances of furnaces and veſſels have been far enough from being as good, as knowledge in mechanicks and dexterity in contrivances might, and, I doubt not, hereafter will, ſupply them with; whether as to the ſaving of fuel, or to the making the utmoſt uſe of the heat afforded by the fuel they do employ, or as to the intending heat to the height, or as to the regulating heat at pleaſure.

IT is ſomewhat wonderful, as well as pleaſant, to ſee, how many veſſels may be duly heated by one fire (perhaps no greater than common diſtillers employ to heat one veſſel) if the furnace be ſo contrived, as that the flame may be forced to paſs in very crooked and winding channels towards the vent or vents, and the heat may be ſkilfully conveyed to ſeveral parts of the furnace, according to the exigency of the work it is to do. And as for the intention of heat, I remember I have had odd effects of it, by the contrivance of a certain furnace, that held but very few coals, and to which I uſed no bellows. But though, by this way, I could vitrify ſometimes the very crucibles, and thought poſſibly I could, with a ſlight alteration, melt down the ſides of the furnace themſelves; yet a diſciple of *Cornelius Drebell*, and a very credible perſon aſſured me, that he knew a way of furnaces, that was yet fitter to bring heat to the ſuperlative degree; and that he himſelf, the relator, could by the mere force of fire in his furnace, bring Venetian talc to flow; which is more, I confeſs, than ever I have been able to do, either in mine, or thoſe of the glaſs-houſe. But experience hath aſſured me, it is eaſy to make a furnace give that heat as expeditiouſly enough, and in other reſpects very conveniently to cupel both gold and ſilver, without the leaſt help of bellows. That alſo furnaces may be ſo ordered, as that the heat may be better regulated, than that in our ordinary ones, I may elſewhere ſhew you cauſe to believe; and in the mean time I ſhall only tell you, that I look upon the ſkill of intending and remitting heat at pleaſure, and eſpecially the being able to keep a gentle heat long and equal, as a thing of much greater moment, both as to phyſick and philoſophy, than chymiſts are wont to think, (the powerful effects of conſtant and temperate heats, being as yet known to few, ſave thoſe, that have made trial of them.) And with lamp-furnaces well ordered, divers things may be done in imitation of nature; ſome friends of mine having, as ſeveral of them aſſure me, in ſuch furnaces brought hen-eggs to manifeſt animation. That alſo furnaces may be ſo built, as to ſave much of the laborants wonted attendance on them, may appear by the obvious invention of athanors, or furnaces with towers, wherein the fire is for many hours, (perhaps for twenty-four, or forty-eight) ſupplied with a competent proportion of coals, without being able to burn much faſter than it ſhould. And that in many caſes the labour of blowing may be well ſpared, and the annoyance of mineral fumes in great part avoided by an eaſy contrivance, is evident by thoſe furnaces, which are blown by the help of a pipe, drawing the air, as they commonly ſpeak, either at the top, as in *Glauber*'s fourth furnace, or at the bottom, or for want of room, upwards, I have ſometimes tried. To which may be added, that the caſting of the matters to be prepared upon quick coals, as *Glauber* preſcribes in that, which he calls his firſt furnace, is, in ſome caſes, a cheap and expeditious way of preparing ſome minerals, though his method of making ſpirit of ſalt in that furnace would not ſucceed, according to his promiſe with me, and ſome of my acquaintance. And there are other more commodious contrivances, by caſting ſome things upon the naked fire, which invites me to expect, that there will be ſeveral good expedients of employing the fire to chymical operations, that are not yet made uſe of, nor perhaps ſo much as dreamed of.

AND as furnaces, ſo the veſſels, that more immediately contain the thing to be prepared, are queſtionleſs capable of being made more durable, and of being better contrived, than commonly they are. Good uſe may be made of thoſe earthen retorts, that are commonly called *Glauber*'s ſecond furnaces, in caſe they be made of earth, that will endure ſtrong fires, and in caſe there be a better way to keep in the fumes, than that he propoſes of melted lead, which I have therefore often declined for another, as having found it liable to ſuch inconveniences as I elſewhere declare.

But for materials that are cheap, and to be diſtilled in quantity, as woods, hartshorn, *&c.* the way is not to be deſpiſed, and is, as we may elſewhere have occaſion to ſhew, capable of improvement; though in ſome caſes this kind of veſſel is inferiour to thoſe tubulated retorts, that were of old in uſe, and mentioned by *Baſilius Valentinus*, and from which *Glauber* probably deſumed that, which we have been ſpeaking of. The utility of the way of ſealing glaſſes hermetically, and of the invention, that now begins to be in requeſt, of ſtopping the bottles, that contain corroſive and ſubtile liquors, with glaſs ſtopples, ground fit to their necks, inſtead of corks, together with ſome other things, not now to be mentioned, keep me, that I ſcarce doubt, but that if we could prevail with the glaſs-men and the potters, to make veſſels of glaſs and earth exactly, according to directions, many things in chymiſtry might be done better and cheaper than now they are; and ſome things may be then done, that with the forms of veſſels now in uſe cannot be done at all. And if that be true, which we find related in *Pliny*, and with ſome other circumſtances in *Dion Caſſius*, of a more ingenious than fortunate man, who, about his time, was put to death for having made malleable glaſs; as the truth of that ſtory, if granted, would ſhew the retrieving that invention a thing not to be deſpaired of; ſo he, that could, now chymiſtry is ſo cultivated, find again the way of making glaſs malleable, would be, in my opinion, a very great benefactor to mankind, and would enable the virtuoſi, as well as the chymiſt, to make ſeveral experiments, which at preſent are ſcarce practicable: and ſome chymiſts would perhaps think the attempt more hopeful, if I tell them firſt, that I remember *Raymund Lully* expreſly reckons it among three or four of the principal virtues he aſcribes to the philoſopher's ſtone, that it makes glaſs malleable; and then, that an expert chymiſt ſeriouſly affirmed to me, that he met with an *adeptus*, who, among other ſtrange things, ſhewed him a piece of glaſs, which the relator found, would endure and yield to the hammer. But what my own opinion is concerning this matter, and what are the (uncommon) inducements I have to be of it, I muſt not here declare.

Glaſs-ſtopples fitteſt for corroſive liquors.

And on this occaſion, I remember I have ſeen an inſtrument of tin or pewter, for the drawing of ſpirit of wine (which you know is one of the chargeableſt things that belongs to chymiſtry) ſo contrived, that whereas in the ordinary way much time, and many rectifications are requiſite to dephlegm ſpirit of wine; one diſtillation in this veſſel will bring it over from wine it ſelf, ſo pure and phlegmleſs, as to burn all away. And I remember, that the ancient French chymiſt, in whoſe laboratory I firſt ſaw one of theſe inſtruments, told me, that it was invented not by any great alchymiſt or mathematician, but by a needy Pariſian chirurgeon. And now I ſpeak of ſpirit of wine, I ſhall add, that as the charges of chymiſtry would be very much leſſened, if ſuch ardent ſpirits could be had in plenty, and cheap; ſo I think it not improbable, that in divers places there may be found, by perſons well ſkilled in the nature of fermentation, other vegetable ſubſtances far cheaper than wine, from which an inflammable and ſaline ſulphureous ſpirit, of the like virtue, for diſſolving reſinous bodies, drawing tinctures, *&c.* may be copiouſly obtained. For not only it is known, that cider, perry, and other juices of fruits will afford ſuch a ſpirit; and that moſt grains, not very unctuous, as barley, wheat, *&c.* will do the like, but other berries, that grow wild, as thoſe of elder, will yield a vinous liquor. And in the *Barbadoes* they make a kind of wine, even of roots, (I mean their *Mobby*, which they make of potatoes; as I have alſo, for curioſity's ſake, made bread of the ſame roots;) nay, even from ſome ſorts of leaves, ſuch a liquor may be obtained. For I have obſerved roſes, well fermented, to yield a good ſpirit very ſtrongly taſted, as well as inflammable. And as to the preparing of pure ſpirit of wine it ſelf, I know ways (and one of them cheap)

That inflammable ſaline ſulphureous ſpirits may be drawn from other ſubſtances cheaper than wine.

cheap) that may exceedingly ſhorten the time, and pains of dephlegming it: but that being to be done otherwiſe, than by any peculiar contrivance of furnaces or glaſſes, I reſerve it for a fitter place, in one of the following eſſays.

Inſtances in divers particulars, how the naturaliſt may find cheaper ways of heating the chymiſts furnaces.

AND as more expedient and thrifty ways than the vulgar ones, of making chymical furnaces and veſſels, may be deviſed; ſo it is to be hoped, that a ſkilful naturaliſt may find cheaper ways of heating the chymiſt's furnaces, or diſtilling in his veſſels, (either by finding combuſtible materials, not formerly in uſe in the places where we work, or by making thoſe already imployed fitter for uſe) by bringing them, by ſome cheap alterations, either to give a greater, or a more durable heat; or to be leſs offenſive by their ſmokes or ſmells; or elſe by diſcovering ſome cheap way of doing, in ſome caſes, without fire, what was wont to be done by it.

Of charring coals, ſo that while it chars, it gives an intenſe heat, fit to melt or calcine minerals.

WE ſee, that in ſome places, eſpecially here in *England*, where charcoal was only burnt in furnaces, pit-coal is ſubſtituted in its room. And at this day there are ſeveral of thoſe, that make aqua fortis in great quantities, that diſtil it with ſuch coals, which coſt nothing near ſo much as thoſe made with wood. And experience hath informed me, that even in other ſorts of furnaces, the ſame fuel may be employed, provided the bars of the grates be ſet wider aſunder, and a little charcoal be mingled with it for the better kindling: and ſince of late years pit-coal have been found in ſeveral places among us, where they were not formerly known to be, it ſeems not improbable, that many other countries may afford chymiſts, and the reſt of their inhabitants, the like advantage, if ſearch were duly made, by boring of the ground, by the obſervations of the waters, and the ſteams of places ſuſpected, and by other ways of inquiry, that a ſkilful man might direct. But becauſe the abundant ſmoke of pit-coal uſes to be very offenſive, and the ſmaller coals eaſily run through the grates, and becauſe of other inconveniences, there hath been a way found out of charring theſe coals, and thereby reducing them into coherent maſſes, of a convenient bigneſs and ſhape, and more dry and apt to kindle. And theſe, though quantity for quantity, their price be little inferiour to that of charcoal, yet thoſe, that conſume great proportions of coals, tell me they find them almoſt as cheap again, in regard they will not only laſt much longer, but give (eſpecially near at hand) a far more intenſe heat. And therefore it muſt be a very uſeful thing to chymiſts, to ſhew a way of charring ſea-coals, without the help of thoſe pots, which make them of the price they now bear. And that it is not only poſſible, but very eaſy, I could quickly ſhew you, if it would not prejudice an induſtrious laborant, whoſe profeſſion being to make chymical medicines in quantity, obliges him to keep great and conſtant fires, and did put him upon finding a way of charring ſea-coal, wherein it is, in about three hours or leſs, without pots or veſſels, brought to charcoal; of which having, for curioſity ſake, made him take out ſome pieces, and cool them in my preſence, I found them upon breaking to appear well charr'd, and much thereof in ſhew not unlike a marcaſite. And that, which was very convenient in this contrivance, was, that whilſt the pit-coal was charring, it afforded him a very intenſe heat to melt or calcine the minerals, he had occaſion to expoſe to it: And he confeſt to me, that by this method, he ſaved three parts in four of the charges the keeping ſuch great and conſtant fires, with common charcoal, would coſt him. In *Holland* likewiſe, they have a way of charring peat, (which is a combuſtible turf, that they dig under ground;) and a ſkilful diſtiller, that much employed it, commends it to me, as a very good fuel, even for chymical fires: which I therefore mention, becauſe the way of charring peat is not yet brought into ſeveral countries, where peat is digged up; and probably, it would be found in divers regions, where it is yet unknown, if due ſearch were made for it. To which I may add, that it is not unlike, that ſome

Of charring peat.

countries may afford ſuch combuſtible materials fit for chymical furnaces, as have not, as yet, been ſo much as named by mineraliſts: as I remember I have ſeen, and had, a ſort of coals, ſome of which looked like marchaſites, that burned clear with a good flame, and had this convenient quality for the chymiſt's uſe, that they were not apt, like the common pit-coals, to ſtop the grates with their cinders, but burnt to whitiſh aſhes, almoſt like charcoal made of wood; and yet gave ſo great a heat, that an induſtrious chymiſt of my acquaintance, who kept many things conſtantly at work, found it worth while to have them brought him, above a day's journey on horſes backs.

Of digeſtion and diſtillation without fire.

But it is not impoſſible, that when men grow better naturaliſts, they may find ways of exciting heat, enough for many chymical operations, without the help of fire, and conſequently, without the conſumption of fuel. We find, that by the attrition of hard bodies, conſiderable degrees of heat may be produced, not only, in combuſtible materials, as wood, and the like, (which would therefore be improper to be here inſiſted on;) but in others alſo, and particularly in iron and ſteel, one may by attrition ſoon produce a ſmart heat, as you may quickly try, by nimbly filing a piece of iron, with a rough file, or ſwiftly rubbing, though but a few minutes, a thin piece of ſteel againſt a board. And whether ſome contrivance may not be found, by the help of cheap engines moved by water, or otherwiſe, to produce a durable heat in iron veſſels, fit to digeſt in, we may elſewhere have farther occaſion to conſider; but this is known, that from ſome ſucculent plants a liquor may be drawn, only by expoſing them in glaſſes, purpoſely contrived, to the beams of the ſun. And there is nothing more common, than for chymiſts to make their digeſtions by the warmth of horſe-dung, whereby they might alſo (as ſome analogous trials incline me to think) conveniently enough diſtil ſome fermented liquors; eſpecially if the way were improved by the ſkilful addition of quick-lime, and ſeaſonable aſperſions of water. And I doubt not, but many cheap materials might, by a few trials, be found, whereby portable digeſting furnaces, without fire, (if I may ſo call them) might be made, without the ill ſmell and naſtineſs, which diſcommends the uſe of horſe-dung. For not only we ſee, by what happens in the ſpontaneous heating of malt, and ſome other familiar ſubſtances, that probably moſt ſorts of grains and berries, fit for fermentation, may be brought to yield, for a good while, a heat great enough to putrify or digeſt with: but I have, ſeveral years ago, by many trials found, that I could, by invironing glaſſes with refuſe hay, well preſſed down, and equally wetted throughout, produce for divers days ſuch a heat, as made me decline the employing of horſe-dung; and yet (which is the chief thing, for which I mention this) the quantity of hay was ſo ſmall, that in all my trials I found not, that the hay did of it ſelf, though kept cloſe enough, take fire, as elſe is uſual in ricks of hay not ſufficiently dried, where the quantity, and conſequently the weight, that preſſes the lowermoſt parts cloſe together, is conſiderable.

Ways of diſtilling ſpirit of urine.

Of diſtilling it with

But farther, in divers operations, where an actual fire is requiſite, it may be hoped, that knowing men may diſcover ways of ſaving much of the fire, and making ſkill perform a great part of the wonted office of heat. To obtain the ſpirit of freſh urine, you muſt diſtil away near nine parts of ten, which will be but phlegm, before the ſpirit or volatile ſalt will (and that ſcarce without a pretty ſtrong heat) regularly riſe. And there are ſeveral chymiſts, that to this day make uſe of no better way of diſtilling urine: but he, that knows, how putrefaction opens many bodies, may eaſily ſave himſelf the expence of ſo much fire. For if you let urine ſtand well ſtopped, for eight or ten weeks, the ſaline and ſpirituous parts will ſo extricate themſelves, that the ſpirits, that before ſtayed behind the phlegm, will now, even with the gentleſt heat, riſe up firſt, and leave the phlegm behind. And on this occaſion I ſhall teach you, what I do not know to have been mentioned by any writer; namely, that even of freſh urine, without digeſtion or putrefaction, I can, by a very cheap and eaſy way, make ſubtile and penetrant ſpirit aſcend, firſt, even in a gentle heat. And I am wont to do it, only by pouring urine, how freſh ſoever, upon quick-lime, till it ſwim ſome fingers breadth above it, and then diſtilling it as ſoon as I pleaſe. But I did not find, upon many trials, that this ſpirit, though even without rectification very ſtrong and ſubtile, would coagulate ſpirit of wine, like that of putrified and fermented urine; though perhaps for divers other purpoſes it may be more powerful.

lime without fermentation.

That ſo diſtilled, it doth not coagulate ſpirit of wine, as in the uſual diſtillation.

And here I ſhall advertiſe you, that whereas I juſt now took notice, that there was a pretty ſtrong fire requiſite to force up the ſalt of unfermented urine out of that part, which, after the abſtraction of the phlegm, remains of the conſiſtence of honey; trial hath informed me, that the volatile ſalt may out of the thick liquor be obtained, better and more pure, with eaſe, and with a ſcarce credibly ſmall heat, barely by tempering the urinous extract with a convenient quantity of good wood-aſhes, whereby (for a reaſon elſewhere to be conſidered) the volatile part of the ſalt of urine is ſo freed from the groſſer ſubſtance, that with ſtrange facility it will aſcend fine and white, to the top of very tall glaſſes. But of the differing preparation of urine, more perhaps elſewhere. I now proceed to tell you, that I think it not unlikely, that even bodies, which are more groſs and ſluggiſh, may, by the affuſion of ſuch menſtruums, as human induſtry may find out, be far more eaſily, either, volatilized or unlocked, than common chymiſts are wont to think. For I know a liquor, not very rare among chymiſts, by whoſe help I have, often enough, diſtilled ſpirit of nitre (whoſe diſtillation requires much about the ſame violence of fire with that of aqua fortis) even in a moderate heat of ſand, and without a naked fire. This ſpirit may eaſily enough be brought over, even in a head and body: and for a wager, I could obtain a little of it without any fire or outward heat at all. And I remember alſo, that having once digeſted a certain menſtruum, for a very ſhort time, upon crude antimony, and abſtracted it, in a very gentle heat of ſand; the liquor not only brought over ſome of the antimony in the form of red flowers, ſwimming in it, and united other parts of the mineral, with it ſelf, in the tranſparent liquor; but the gentle heat raiſed to the top of the retort divers little maſſes of a ſubſtance, that were very tranſparent, like amber, which were inflammable, and ſmelt, and burnt blue, juſt like common ſulphur: and yet the menſtruum, which was eaſily again recoverable from the antimony, was no ſtrong corroſive, taſting before it was poured on, not much unlike good vinegar.

Of the power of good menſtruums in facilitating diſtillation.

But beſides all the ways above mentioned of ſaving the chymiſt either time, or fire, or labour; I deſpair not, that divers others, yet unthought on, will be in time found out by the induſtry of ſkilful men, taking notice of the nature of things, and applying them to chymical uſes; as we ſee, that by amalgamations with mercury, the calcination of gold and ſilver may be much eaſier performed, than by a long violence of fire. And (if it be true, what *Helmont* and *Paracelſus* tells us, of their immortal liquor alkaheſt) medicines far nobler, and otherwiſe more difficult to make, than thoſe hitherto in uſe among the chymiſts, may be prepared with greater eaſe, and expedition, and with far leſs expence of fire, than the nature of the metals, and other concretes to be opened by it, would let a vulgar chymiſt ſuſpect. However, I ſee no cauſe to doubt, that there may be menſtruums found, that will much facilitate difficult operations; ſince, not to mention again the liquor I lately told you would work ſuch a change on nitre, (and, I might have added, on ſome other compact bodies) it is very like, there may be menſtruums found, that will not be ſo ſpoiled by a ſingle operation, made with them, as our vulgar ſaline ſpirits are wont to be. For I have tried, that a menſtruum, made by the bare diſtillation of good verdigreaſe, will not only draw, as I have

That the calcination of gold is facilitated by amalgamations with mercury.

The power of verdigreaſe diſtilled, in

drawing tinctures of glaſs of antimony, &c.

I have formerly told you, a tincture of glaſs of antimony, or perform ſome other like operation for once, but being drawed off from the diſſolved body, or the extraction, will again ſerve, more than once, for the like operation upon freſh materials.

That the naturaliſt may find out ways to preſerve medicines longer and better than is uſual.

Of fuming liquors with ſulphur.

And adding a little of the white coagulum made of the pure ſpirits of wine and urine.

The fifth, and laſt way, *Pyrophilus*, that I intend to mention, of leſſening chymical expences, is, that the naturaliſts may probably find out ways of preſerving ſome chymical medicines either longer or better than thoſe ways that are uſual. But of this preſervation of bodies being like, as I formerly intimated, to have elſewhere further occaſion to treat; I ſhall now only ſay, that the purified juices, liquid extracts, robs, and other ſoft medicaments, made of plants, may be conſerved far cheaper, as well as better than with ſugar, (which clogs moſt men's ſtomachs, and otherwiſe diſagrees with many conſtitutions) in caſe *Helmont* ſay true, where he tells us, that for a ſmall piece of money he can, for I know not how long, preſerve whole barrels of liquor. And a way he intimates, of fuming liquors with ſulphur, I have already told you, is a very good way of keeping them uncorrupted; provided, that (though he preſcribes it not) they be ſix or ſeven ſeveral times (ſeldomer or oftener, according to the quantity or nature of the liquor) well impregnated with that imbalming ſmoke; to which purpoſe it is convenient to have two veſſels, to pour from one to the other, that whilſt the liquor is ſhaking in the one, the other may be well filled with ſmoke. Whereto I ſhall only ſubjoin this ſecret, which a friend of mine practiſes, in preſerving the fumigated juices of herbs, (as I elſewhere inform you, I do to preſerve other things) with a ſucceſs, that I have ſomewhat wondred at; which conſiſts, in adding to the thick liquor to be preſerved, a due, but ſmall proportion of the white coagulum, (which I elſewhere mention) made of the pure ſpirits of wine and urine.

But I have made this excurſion too prolix, and therefore I ſhall only add as a general admonition, that we are not, by the common practice of vulgar chymiſts, to eſtimate what knowing naturaliſts, ſkilled in mechanical contrivances, may be able in time to do, towards the making chymical remedies, as well more cheap as more effectual: and indeed, to make them more effectual, is the beſt way to make them more cheap.

That the moſt principal way of leſſening the charge of cures would be the finding out new and more effectual remedies.

For, *Pyrophilus*, after all the ways, that I have mentioned, whereby the charges of the therapeutical part of phyſick may be leſſened; I muſt advertiſe you, both, that I make no doubt, but that there may be others found, which either through want of ſkill or leiſure I have pretermitted, and that I have not yet named the principal of all; which is, that the deep inſight into natural philoſophy may qualify him, that hath it, by ſeveral ways, and eſpecially by diſcovering the true cauſes and ſeats of diſeaſes, to find out ſuch generous and effectual remedies, (whether ſpecifick, or more univerſal arcana) as by quickly freeing the patient from his diſeaſe, may exempt him from needing either much phyſick from the apothecary, or many chargeable viſits from the doctor, or chirurgeon. Thus the rich merchant I mentioned, in one of the former eſſays, to have been freed, by a ſpecifick, from the gout; and the young lady cured of her fiſtulas, by the infuſion of millepedes; might well, in the ordinary way, have ſpent, even ſuppoſing them thrifty, an hundred times more upon phyſicians and phyſick, than the potent and nimble remedies, whereby they were ſo happily recovered, coſt them.

[To which I ſhall add, by way of confirmation, both of this, and of what I lately told you, concerning the efficacy, that may be, even in ſlightly prepared ſimples, what I came to learn, ſince the writing of the former part of this eſſay; namely, that a young lady, who (though of great birth, is yet of far greater beauty and virtue, whom I preſume I need not name to you) having been long troubled with an almoſt hereditary epileptical diſtemper, and after having been wearied by courſes of phyſick preſcribed her by the famouſeſt doctors, that could be procured, without at all mending but rather growing worſe, ſo that ſometimes ſhe would have, in one day, eight or ten of ſuch diſmal fits, as you and I have ſeen her in; was cured only by the powder of true miſletoe of the oak, given as much as would lie upon a ſix-pence, early in the morning, in black cherry-water, or even in beer, for ſome days near the full moon. And I am aſſured, partly by the patient herſelf, and partly by thoſe, that gave her the medicine, that though it had ſcarce any other ſenſible operation upon her, and did not make her ſickiſh, eſpecially when ſhe ſlept upon it; yet after the firſt day ſhe took it, ſhe never had but one fit. And this remedy an ancient gentleman, who, being caſually preſent, when ſhe ſuddenly fell down as dead, gave it her, profeſſed himſelf to have conſtantly cured that diſeaſe with it, when he could procure the right ſimple, which is here exceeding ſcarce. And what further experiment ſome friends of yours have ſucceſsfully made, I may elſewhere have occaſion to relate.]

An hiſtory of a radicated epilepſy, that was cured by the powder of miſletoe of the oak.

To which I ſhall only add, that one of the ſkilfulleſt methodiſts I ever knew, having had much ado to preſerve a young couſin of yours from a very dangerous cough, by a long courſe of phyſick; the party, at the beginning of the next winter, falling into a relapſe more threatning than the firſt diſeaſe, was reſcued from it in two or three days, by not many more takings of a ſpecifick ſent her, made of nothing elſe but hartſhorn prepared, as I lately taught you. And if ſuch ſlight medicines, conſiſting, each of them, but of a ſingle ſimple, not elaborately prepared, may ſometimes (for I ſay not always) perform ſuch ſpeedy cures even in chronical diſtempers; what may not be hoped from the *arcana majora* (ſuch as *Paracelſus*'s *Laudanum*, ſo praiſed by *Oporinus* himſelf, and *Butler*'s *Driff*, ſo extolled by *Helmont*) when the ſkilfulleſt preparations of the nobleſt ſimples ſhall come to be known by learned and judicious men, intelligent in the theory of phyſick, and eſpecially verſed in the hiſtory of diſeaſes? And though *Riverius* were none of the greateſt naturaliſts, or, at leaſt, chymiſts; yet if in his *Obſervations*, and elſewhere, he flatter not his own *Febrifugum*, how many patients did that one ſpecifick reſcue from quartans, that would elſe probably have proved as chargeable as tedious?

BUT, *Pyrophilus*, having ſaid ſo much, that I fear you have thought it tedious, to ſhew, that a naturaliſt, ſkilled in chymiſtry and the mechanicks, may aſſiſt the phyſician to make his cures leſs chargeable, it is high time, that after ſo long an excurſion, I proceed to conſider, in what other particulars he may be a benefactor to the phyſician's art.

## CHAP. VIII.

Other proofs, that the naturaliſt's ſkill may improve the pharmaceutical preparation of ſimples.

FIFTHLY, then, that the naturaliſt's ſkill may improve the pharmaceutical preparations of ſimples, by ſeveral ways partly touched already, and partly to be, either, added or farther treated of; the great variety of new remedies, wherewith the laboratories of chymiſts have furniſhed the ſhops of apothecaries, may convincingly inform you. To which I muſt take the liberty to add, (and that upon ſerious conſideration) That *the chymical preparations, hitherto common in Diſpenſatories, are, as to the generality of them, far enough from being the moſt dextrous, or noble, that can be deviſed.* For our vulgar chymiſtry (to which our ſhops owe their venal ſpagyrical remedies) is as yet very incomplete, affording us rather a collection of looſe and ſcattered (and many of them but caſual) experiments, than an art duly ſuperſtructed upon principles and notions, emergent from ſevere and competent inductions, as we have elſewhere endeavoured more particularly to manifeſt. And therefore, till the principles of chymiſtry be better known, and more ſolidly eſtabliſhed, we muſt expect no

**Of the beſt ways to correct opium.**

**Of the beſt way of correcting of mercurius vitæ.**

**An excellent medicine made of thoſe churliſh minerals, quickſilver and antimony.**

other, than that very few vulgar chymical remedies ſhould be of the nobleſt ſort; and that in the preparation of many others, conſiderable errors ſhould be wont to paſs unheeded, and faults groſs enough, be apt to be miſtakenly committed. But of this ſubject we may elſewhere have divers occaſions to entertain you; and our ſingle eſſay, *of the Chymical Diſtinctions of Salts*, will perhaps diſcover to you no ſmall miſtakes, in the preparation of divers applauded vulgar medicines. For it is not the elaborateneſs, but the ſkilfulneſs of preparations, that produceth the noble remedies; and a few teeming principles well known and applied will enable a man with eaſe to make better remedies, than a great many furnaces and glaſſes, though never ſo well contrived, and though very uſeful in their kind. To make this out in ſome meaſure, I ſhall name ſome ſuch inſtances, as may withal confirm what I formerly delivered in this eſſay, touching the poſſibility and uſefulneſs of correcting either poiſonous, or otherwiſe very noxious ſimples. I never knew opium ſo much corrected by ſaffron, cinnamon, and other aromatical and cordial drugs (wherewith it is wont to be made up into laudanum) nor by the moſt tedious tortures of *Vulcan*, as I have known it by being a while digeſted in wine, impregnated with nothing, but the weight of the opium of pure ſalt of tartar, as we elſewhere more fully declare. (A much nobler laudanum may be made by adding to the opium, inſtead of the ſalt, two or three appropriated ſimples, and by due fermentations and digeſtions of them with it.) And for that violent vomiting-medicine, by chymiſts flatteringly enough called *mercurius vitæ*, a whole pound of cordial conſerves, or liquors, will not ſo well moderate its evacuating force, as the keeping it continually ſtirring in a flattiſh and well-glazed earthen veſſel, placed over a chaffing-diſh of coals, till it emit no more fumes, but grow of a greyiſh colour: which I am very credibly informed to be the preparation of *mercurius vitæ purgans*, oftentimes mentioned and commended by the famous practitioner *Riverius*, in his *Obſervations*. A not unlike, but far more ſudden, correction of that active powder, I elſewhere teach. And as for thoſe operative minerals, quickſilver, and antimony, though long experience of their churliſh and untractable nature has made many of the warier phyſicians and chymiſts ſhy to meddle with either of them ſingle; yet theſe concretes which ſeem ſo incorrigible, may, by being barely (in the gradual diſtillation of butter of antimony) ſublimed up together in a cinnabar, and then that cinnabar, ſix or ſeven times reſublimed *per ſe*, be united into a medicine, that not only is not wont to work, either upwards or downwards, but of which I have known ſafely taken, even in ſubſtance, to the doſe of many grains; and a few drachms of which, infuſed in a pound or two of wine, hath made it of that inoffenſive efficacy (taken, in the quantity of a ſpoonful or two, daily upon an empty ſtomach) that, if it ſtill ſucceed as well as we have obſerved it two or three times to do, we may think, that our having thus acquainted you with the virtue of this unlikely remedy, (though we have alſo met with it, even in printed books) may make you amends for all the reſt of this tedious diſcourſe. I once knew a ſlight (but altogether new and tedious, as well as philoſophical) preparation of ſalt of tartar correct and tame ſuch poiſons, as ten times the quantity of the higheſt vulgar antidotes, or cordials, would (I was confident) ſcarce have ſo much as weakened: and I have known by the ſame prepared ſalt, dexterouſly ſpecificated by ſimples, the virtues of ſome vegetables ſo exalted, that, without any cathartick or emetick operation, they have (if many patients, of whom I had caſual opportunities to inquire of the effects of thoſe remedies upon them, do not miſ-inform me) proved more effectual in taming divers ſtubborn diſeaſes, than *crocus metallorum*, *mercurius vitæ*, (as it is abuſively called) and thoſe other dangerous remedies, which make the vulgar wont to ſay of chymiſts, that they quickly either cure their patients, or kill them. And to let you ſee, *Pyrophilus*, by one plain, and yet noble inſtance, that the knowledge of the ſpecifick qualities of things, ſkilfully applied to preparations, may perform, with eaſe, what neither coſtly materials, nor elaborate proceſſes are able to effect; give me leave to inform you, that, whereas chymiſts and phyſicians have not been able by infuſing the true glaſs of antimony (made *per ſe*) in ſpirit of wine, or the richeſt cordial liquors, nor yet by torturing it after ſeveral tedious and artificial manners, to deprive it of its emetick quality; that vomitive faculty, of antimonial glaſs, may be corrected by ſo ſlight a way, as that of digeſting it with pure ſpirit of vinegar, till the menſtruum be highly tinged. For if you gently abſtract all the liquor, and on the remaining yellow or red powder you digeſt well dephlegmated ſpirit of wine; you may after a while obtain a noble and not emetick tincture; of which though *Baſilius Valentinus* preſcribes but five or ſix drops for a doſe, yet a domeſtick of mine having, out of curioſity, taken to the quantity of thirty drops at a time, he found it not at all vomitive. And this tincture we the rather mention, becauſe, not only *Baſilius Valentinus*, but other ſkilful perſons, highly extol it for ſeveral diſeaſes.

**Ways to take away the vomitive faculty of antimonial glaſs.**

**See his Currus triumphalis antimonii.**

AND let me add, *Pyrophilus*, (and be pleaſed to mark well what I tell you) that by bare reiterated digeſtions, and fermentations, there may be prepared, out of many vegetables, ſaline and ſulphureous eſſences (whoſe bulk is exceedingly ſmall, in proportion to the concretes whence they are extracted) which will keep many years, as I can ſhew you ſome above three years old, and contain more of the craſis (if I may ſo call it) of the ſimple, than the vulgar vegetable waters, ſpirits, extracts, or ſalts, hitherto extant in laboratories and ſhops. But there is ſo great a length of time required to the preparation of theſe efficacious juices, that my ambulatory condition of life hath not allowed me to furniſh my ſelf with many of them.

**A new and excellent way to get the primum Ens, or eſſence, of ſome vegetables.**

AND, *Pyrophilus*, if you will not diſbelieve a perſon, for whom you have ſo juſt an eſteem, as you have for that ingenious, and experienced Monſieur *L. F.* who was the French King's chymiſt, when you knew him at *Paris*; I can preſent you with a yet nobler inſtance, to perſuade you, that, if ſkill be not wanting, a ſingle herb, without any violence of fire, may, by other ways, than are in uſe among chymiſts, be eaſily enough brought to afford medicines, endowed with ſome nobler virtues than any of the moſt compounded, coſtly, and elaborate medicines, whether minerals or others, that are to be met with among vulgar chymiſts. This efficacious part of the plant, whence it is obtained, *Paracelſus* calls the *primum ens* of the plant, that yields it: but though, indeed, I have found the way of preparing it much plainer, and better delivered, than is uſual in his writings, at the end of his book *De Renovatione & Reſtauratione*; yet I freely acknowledge, that I ſhould ſcarce have thought it worth the trial, if it had not been for what the experienced chymiſt above-mentioned affirmed to me, upon his own obſervations, concerning it, partly, becauſe I am not wont to be forward, ſo much as to try long proceſſes upon *Paracelſus*'s credit, and partly, becauſe what he calls *Sal Solutum* ſeemed to me ſomewhat ambiguous. Since in the ſame page, teaching to draw the *Ens primum* of gold and antimony, he makes not uſe of ſea-ſalt, but of (a ſalt of an incomparably higher nature) his *Sal circulatum*: and in the proceſs immediately preceding ours, to make the *Ens primum* of emeralds, he preſcribes the calcining them *in ſale ſoluto*, which agrees far better with his *Sal circulatum*, than with any ſolution of ſea-ſalt; which ſeems very unlikely to be able to calcine, and, as he ſays it muſt, diſſolve emeralds. But the way, that our French chymiſt told me he uſed, was in ſubſtance this: Gather, in a convenient ſeaſon and time of day, balm, for inſtance, or ſome other fit herb, (for experience hath taught, both him and me, that all herbs are not fit, by this way, to be reduced into liquors) and having beaten it well, in a marble mortar, to a ſoft maſh, placed in a bolt-head hermetically ſealed, to digeſt forty days in a dunghill, or ſome analogous heat; then, opening the veſſel, take out the matter, which will be far more liquid than before, from which, having ſeparated the groſſer parts, you muſt digeſt it in a gentle bath, that the yet remaining groſſer parts may ſubſide; to which, being filtrated, you muſt, according to him, (for I find not that *Paracelſus* requires it) join the fixed ſalt of the groſſer parts above mentioned, dried and calcined. To this prepared liquor, you muſt add equal parts of the liquor of good ſea-ſalt well purified, and then melted, and ſuffered to run *per deliquium*. This liquor, being alſo ſealed up in a convenient glaſs, muſt be expoſed to the ſun for about ſix weeks; at the end of which time there will ſwim at the top of it the *primum Ens* of the plant in a liquid form, tranſparent, and either green or red, or, perhaps, of ſome other colour, according to the nature of the plant. And though *Paracelſus* preſcribes but celandine, and balm, to be uſed, yet having inquired of our chymiſts, he told me, he had made ſuch *prima Entia* of ſcrophularia, and, as I remember, of one or two other herbs. But that, which makes me thus, particularly, take notice of theſe kind of medicines, is, that not only *Paracelſus* aſcribes to the *primum Ens* of balm, (or celandine) the power of renovating them, that uſe ſo much of it in good wine as will give it a tincture, early every morning; till, firſt of all the nails of their fingers, then thoſe of their toes, afterwards their hair, and teeth, fall off; and laſtly, the ſkin be dried and exchanged for a new one. But your ingenious acquaintance aſſured me ſeveral times, and once in the preſence of a famous phyſician, and another virtuoſo, to whom he appealed, as knowing the truth of what he ſaid; that an intimate friend of his, whom he named to me, having, after the above mentioned manner, prepared the *primum Ens* of balm, to ſatisfy himſelf the better of its effects, made the trial upon himſelf, and took of it, according to the preſcription, for about a fortnight: long before which his nails, both of hands and feet, began to looſen themſelves from the ſkin, (but without any pain) which at length falling off, of their own accord, this gentleman keeps yet by him in a box for a rarity; but would not purſue the trial any further, being ſatisfied with what he had found, and being in no need of ſuch phyſick. But having given of the ſame medicated wine, for ten or twelve days, to a woman, that ſerved in his houſe, and was near ſeventy years of age, without letting her know, what he expected it ſhould do; her *purgationes menſtruæ* came upon her again in a ſufficiently great quantity to frighten her ſo much, that he durſt proſecute the experiment no further. And when I aſked, why he made no trial upon beaſts; it was anſwered, that though he had but little of the medicine, yet he put apart an old hen, and moiſtening her food with ſome drops of it for a week, about the ſixth day ſhe began to moult her feathers by degrees, till ſhe became ſtark naked: but before a fortnight was paſt, ſhe began to regain others, which when they were come to their full growth, appeared fairer, and better coloured than the firſt: and he added, that, beſides that her creſt was raiſed, ſhe alſo laid more eggs, than ſhe was wont. And as to the *primum Ens* of the greater *ſcrophularia*, by the relator himſelf, though he aſcribed not to it any renovating power, as to that of balm or celandine; yet he aſſured me, he had found it ennobled by other great and extraordinary virtues. But of this kind of preparation, I might ere now poſſibly have been able to give you a better account, if, in my trials about them, I had not met with ſome unhappy accidents, which I hope my next attempts will eſcape: which if they do, I may poſſibly, with an account of them, ſend you one of ſome attempts to prepare the like medicines another and ſhorter way, together with a conſideration, whether *Paracelſus* and others deſervedly call ſuch accidents, as the above-mentioned change of nails, hair, and even of teeth, a real renovation or rejuveniſcence.

The influence of theſe prima Entia to cauſe renovation or rejuveniſcence.

It

In tracta-tulo cui titul. Sequuntur quædam imperfectiora.

Of Helm. Via media of Elixir Proprietatis.

It is likewiſe a way of preparation, differing enough from thoſe, that are common among chymiſts, which *Helmont* (as he ſays out of commiſeration to the ſick) delivers, where he teaches that, which he calls the *Via Media* of making the *Elixir Proprietatis*, of which he gives us this commendation: *Hoc medicamine tam quartanam, quàm continuam ſtatim abſolvi. Adeò ut qui noctu ſuſceperat ſacroſanctum viaticum, & olei extremam unctionem, me in prandio convivam circa lectum habuerit.* And though many think, that he has rather fraudulently than rightly ſet the proceſs down; yet experience has invited me to abſolve him in this particular. (Though I muſt tell you, that becauſe a languid heat is not ſufficient to make a ſpirituous liquor aſcend, and circulate as he requires; it is not every chymiſt, that will, eſpecially in his firſt trials, avoid the breaking of the glaſſes, or at leaſt the burning of the materials, to which accidents this preparation is very obnoxious, if it be not as well watchfully as ſkilfully made.) And though for my part I have ſcarce uſed this elixir but as a cordial; yet I know ſome very expert phyſicians, that have given it with great ſucceſs in divers difficult caſes, and particularly a friend of the younger *Helmont*'s gives it ſo ſucceſsfully, that partly his patients, and partly others, that have tried it, have ſometimes taken of him, at a great rate, whole pounds in a year or two; and yet I know by his own confeſſion, that beſides the ſkill he employs in making it dextrouſly, he adds nothing but one ingredient, to which, I confeſs, I am not apt to aſcribe any conſiderable part of the efficacy of the medicine; which, when made, he ſometimes perfumes by cohobations with muſk and amber.

And the perfuming it with muſk and amber.

A commendation of Helmont's medicines.

And, *Pyrophilus*, that you may not wonder, that I, who think much of *Helmont*'s theory ſcarce intelligible, and take great exceptions at many things in his writings, ſhould yet now and then commend medicines upon his authority; I muſt here confeſs to you once for all, that (always excepting his extravagant piece, *De magnetica vulnerum curatione*) I have not ſeen cauſe to diſregard many things he delivers, as matters of fact, provided they be rightly underſtood; having not found him forward to praiſe remedies without cauſe, though he ſeem to do it ſometimes without meaſure, and having more than once, either known, or even had conſiderable effects of medicines he commends, which one of the happieſt practitioners I have met with, and one not laviſh in extolling chymical remedies has ſolemnly aſſured me, he has generally, though not always, found more than ordinarily effectual. And upon occaſion of this odd preparation of the *Elixir Proprietatis*, I ſhall add, that, ſince experience ſhews us, by what is daily done in chymical laboratories, that upon the operation of the fire upon ſeveral concretes, ſubſtances of nature oftentimes very differing both from the body, that afforded them, and from one another, may be obtained; as the oils, and fixt ſalts even of cold plants, or hot; ſince alſo, by the mixture of active bodies new concretes, endowed with new qualities, may be produced; as we ſee, that *ſaccharum Saturni* emergeth from the conjunction of lead, with the acid ſalt, diſtilled vinegar; and ſince the ſame concrete, according to the differing manners, after which it is handled, may acquire differing qualities, as is clear in the various medicines, afforded us by quickſilver, and by antimony, according as each of them is ordered; I cannot but think, that if chymiſtry did no more than aſſiſt us, by the reſolution of bodies, to extricate their more active parts, and partly by ſuch reſolutions, and partly by aſſociating bodies together, to alter the former texture of nature's productions, or preſent us with new concretes of new textures; by this very means, if men want not curioſity, and induſtry to vary and proſecute experiments, there muſt neceſſarily ariſe ſuch a ſtore of new and active medicines, that, in all probability, many of them will be found endowed with ſuch virtue, as have not been, at leaſt in that degree, met with in the uſual medicines, whether ſimple or compound, to be bought in apothe-

Of the power of chymiſtry.

caries ſhops; and conſequently, even without any notable diſcovery, or improvement of principles, chymiſts (even as matters now ſtand with them) may conſiderably add to the pharmaceutical part of phyſick. But if the operations of chymiſtry were ſeriouſly inquired into, and throughly underſtood, I make little doubt, but by a ſkilful application of them, and eſpecially by a ſeries of them, in a rational and orderly way, ſucceeding one another, there may be found out a great many preparations of remedies, both very differing from the common ones, and far more noble than they. And to make this ſeem probable, I need but repeat ſome of the examples formerly mentioned; to which I ſhall add now, that experience has informed me, there is a way, whereby firmer conſiſtent ſubſtances, belonging to the bodies of animals, may, without the addition of any extraneous matter, and without any violence of heat, be reduced almoſt totally into liquor: and if I much miſremember not, theſe liquors, without any violence of heat, afford their ſpirituous and ſaline parts, in a very gentle heat, and that before their phlegm. And I muſt peculiarly inculcate this, that if we had but a few potent menſtruums, to diſſolve and unlock bodies with, I ſcarce know what might not be done in chymiſtry.

Of the power of noble menſtruums particularly.

But when I ſpeak of noble menſtruums, I mean not ſuch, as work like the generality of corroſives, and the like acid or ſaline liquors, which work but upon few kinds of bodies, and ſoon coagulate, or exantlate themſelves by working, and thereby become unfit for future operations; but I mean ſuch, as either are ſeparable with all their efficacy from the diſſolved body; as is ſaid of the alkaheſt, or ſuch ſaline or other piercing liquors, as not being preciſely, either acid, urinous, or alcalizate, can diſſolve a great variety of concretes, without having their virtue. I ſay not impaired, but deſtroyed thereby; and unlock mineral bodies, far more than vulgar menſtruums, (as for inſtance by volatilizing them, or elſe making them irreducible, or working the like grand changes in them;) and if it be not quite ſeparated from the diſſolved body, is yet ſo friendly to human nature, as to be free from either fretting, or other ſuch dangerous and offenſive qualities, and rather to be of it ſelf a powerful medicine. I ſhould therefore exhort both you, and ſuch other ingenious perſons, as wiſh the advancement of chymiſtry, and phyſick, (I might poſſibly add natural philoſophy too) to apply their chymical attempts, chiefly to the finding out of noble menſtruums; for by being poſſeſſor but of one of theſe, a man may be able to do a great number of things, that otherwiſe are not to be performed. As one of our ordinary goldſmiths, by the knowledge he hath of aqua-fortis, can make many uſeful experiments about ſilver and gold, that, before that menſtruum was found out all of his profeſſion in the world were never able in many ages to compaſs.

Helm. de febr. cap. 5. num. 26.

Nor do I much wonder at that advice, which *Helmont* gives thoſe, that aim at the improvement of phyſick, in theſe words: *Quod ſi ad iſtud ignis arcanum non pertingatis* (he was ſpeaking of a prodigious, not to ſay incredible liquor) *diſcite ſaltem, ſalem tartari reddere volatilem, ut hujus medio veſtras ſolutiones perficiatis. Qui etſi ſua ſoluta anaticè homogenea deſerat, digeſtus in nobis; illorum tamen aliquot vires mutuatus eſt, quas intra defert, plurimorun morborum domitrices:* 'But if you come not 'to that arcanum of *Pyrotechny*, learn at leaſt to make the ſalt of tartar volatile, that 'by means of it you may perfect your ſolutions. Which though it leave thoſe 'things, which it diſſolveth, equally homogeneous, being digeſted in us; yet it bor'roweth ſome of their virtues, which it carrieth along with itſelf to overcome 'diſeaſes.'

Helmont de febr. c. 17. verſ. finem.

For concerning this ſalt, he not only elſewhere ſays, *Dicam ſaltem pro ingenuis, quod ſpiritus ſalis tartari, ſi unicornu, argentum, hydrargyrum, lapides cancrorun, vel aliquod è ſimplicibus diſſolverit, nedum febrim, ſed & plures affatim morbos ſanet, &c.* 'I will ſpeak it for their ſakes, who are ingenious, that the ſpirit of 'ſalt of tartar, if it diſſolveth unicorn's horn, ſilver, quickſilver, crabs eyes, or

‘ other like ſimples, it will cure not only fevers, but other diſeaſes in great abundance.’ But in another place he gives us, together with ſome account of its way of working, this great and comprehenſive commendation of it: *Mirum ſanè*, ſays he, *quantum ſal tartari, vel unicum, volatile factum, non præſtiterit: nam omnem è venis amurcam detergit & obſtruentium contumacium, diſpergitque apoſtematum ſuſcepta conciliabula. De hoc ſalis (& non olei) ſpiritu, verum eſt illud Paracelſi, quod quocunque non attigerit, vix alius potentior perveniet:* ‘ It is a wonder what the very ſalt of tartar ‘ alone being made volatile will perform; for it cleanſes the veins of all the feculen- ‘ cies and the cauſes of contumacious obſtructions, and doth diſperſe the congregated ‘ matter of apoſtems. Of this ſpirit of the ſalt (and not of the oil) is that ſaying ‘ of *Paracelſus* true, that whither this medicine cannot reach, there is ſcarce any other ‘ more powerful, that ſhall reach it.’ Theſe paſſages I ſhould not think worth tranſcribing and laying together, but I find, that beſides the concurrent teſtimonies of *Helmont*, *Paracelſus*, and *Baſilius* in praiſe of this ſalt, the generality of the more inquiſitive chymiſts, without excepting the more ſober and judicious, do, by the various and painful, though fruitleſs attempts they have made to volatilize ſalt of tartar, conſpire in acknowledging it a thing highly worth labouring for; nor do I for my part ſee (whatever ſome ſay to the contrary, and however I have indeed found it more difficult, than perhaps a novice in chymiſtry would think) it ſhould be impoſſible; for I have more than once, with eaſe enough, made gold it ſelf volatile, though it be confeſſed to be the fixedeſt body in the world, and conſequently more fixed than ſalt of tartar, which in an open veſſel may be in time made to fly away by a vehement fire. And I have likewiſe, by an unuſual method, that I have elſewhere delivered, more than once obtained from a mixture of crude tartar, and two or three mineral bodies, good ſtore of true volatile ſalt, which I could ſee no juſt cauſe not to think afforded by the tartar. But I muſt confeſs this may be rather a volatile ſalt of tartar, than ſalt (that is alkali) of tartar made volatile; and therefore the principal thing I mention it for, is to ſhew you, that tartar itſelf, by an unuſual way of management, may be brought to afford an unuſual kind of ſalt. But this I can tell you, that an ingenious acquaintance of mine, whom notwithſtanding my wonted diſtruſts of chymiſts, I durſt credit, affirmed to me, that he had himſelf ſeen a true and real *Sal tartari volatile*, made of alkali of tartar, and had ſeen ſtrange things done with it, inſomuch that he believed moſt of the things, that *Helmont* delivers of it. For my part I am inclined to think, that ſalt of tartar may be made volatile, (whether in the form of a ſublimate or a liquor) by more ways than one, though not all of them near equally good. And whereas one of the beſt (if not the very beſt) of the ways of volatilizing it, ſeems to do it principally with ſpirit of wine, and the great difficulty of that way conſiſts in bringing this ſpirit to aſſociate with the ſalt; I have ſeen ſalt of tartar of my own brought to that paſs, which great virtuoſi have long in vain attempted to bring it unto, namely, to flow readily upon a red-hot iron, and alſo to take fire, and burn with a conſpicuous flame, beſides that when it had been dried by a ſmart fire, to drive away any parts, that did not firmly adhere to it, it would yet readily diſſolve in high rectified ſpirit of wine, which you know ſalt of tartar will not otherwiſe do; not to mention the change of its alkalizate taſte, and other leſſer alterations: but what I can farther ſay of this matter, I muſt not declare in this place.

Helm. de ſcholar. humoriſta. paſſ. decept. c. 2. num. 89.

The power of ſal tartari volatilized.

Of the poſſibility of volatilizing it.

AND, *Pyrophilus*, that you may not be, as many other virtuoſi, diſcouraged from labouring for noble menſtruums, by the confident perſuaſion of many, who believe *Angelus Sala* and *Guntherus Billychius*, (whom I deny not to have been learned men, but do not take to have been great maſters of chymical *Arcana)* fit to determine with authority what can, and what cannot be done by chymiſtry; leſt, I ſay, you ſhould be,

That there may be other menſtruums beſides ſuch as are acid, urinous, or alkalizate.

be, by ſuch men's inconſiderate ſeverity, brought to deſpair of ever ſeeing any noble menſtruum, that is not ſharp to the taſte, nor of any of the three peculiar kinds of ſaline liquor; (acid, as aqua fortis; urinous, as the ſpirits of blood, urine, and other animal ſubſtances; nor alcalizate, as oil of tartar *per deliquium*:) I ſhall aſſure you, that to my own knowledge there is in the world a kind of menſtruum, that conſiſts of a pure cryſtalline ſubſtance, that is made by the fire, and as truly ſaline as ſalt of tartar it ſelf; which ſtrange ſalt, though well purified, and readily diſſoluble, as well in dephlegmed ſpirit of wine, as common water, and though it be totally volatile (whence you may gueſs of how ſaline a nature it is) and alſo be either way reducible to a noble menſtruum, does really taſte ſweet; I mean not in the chymical ſenſe, by want of ſourneſs, (as when they ſay, that the *calces* of corroded and precipitated things are dulcified by frequent ablutions) but by a poſitive ſweetneſs. And whereas the vulgar ſaline menſtruums, (which alone ſeem to have been known to *Sala* and *Billychius*) are ſo ſpecificated, if I may ſo expreſs it, that what an acid menſtruum diſſolves, an alcalizate or an urinous will precipitate, *& è converſo*; and whichſoever you chooſe of theſe three ſorts of menſtruums, one of the other two will diſarm and deſtroy it; I have found by trial, not only that a red tincture of glaſs of antimony, being drawn with a menſtruum, that was but a degree to this liquor, I could not precipitate it like our common tinctures, either with ſpirit of urine, or an alcalizate ſolution. But that (which is far more conſiderable) though it would readily mix with acid ſpirits, as oil of vitriol, with volatile and urinous ſpirits, as ſpirits of urine it ſelf, and with alcalizate ſolutions; yet would neither of theſe three make any ebullition at all with it, or ſeem to work at all upon it. But of ſuch matters, no more at preſent.

How theſe ſeveral diſarm and deſtroy one another, and what an acid menſtruum diſſolves, an urinous or alkalizate doth precipitate.

Of a menſtruum like to all theſe.

## CHAP. IX.

That chymiſtry it ſelf (much more phyſiology) is capable of affording a new and better methodus medendi.

YOU will perhaps expect, *Pyrophilus*, that treating of the advantages, that may accrue to the therapeutical part of phyſick, from a more accurate knowledge of natural philoſophy, I ſhould tell you with the chymiſt, that chymiſtry it ſelf, and much more phyſiology in its full extent, is not only capable of improving the pharmaceutical part or preparations for remedies, (for that we confeſſed already;) but alſo of affording us a new and much better *methodus medendi*, or ſkill of uſing the helps, that nature or art hath provided againſt diſeaſes. And indeed the phyſician's art is ſo difficult, and a man muſt know ſo many things, to be, though not tolerably, yet perfectly ſkilled in it, that it may, without diſparagement to phyſicians, be thought yet capable of being improved, if not of being reformed. *Hippocrates* begins his aphoriſms with a complaint, that life is ſhort, but art long. And *Paracelſus* himſelf, though he ſay after his boaſting manner, *Ars eſt longa, vita brevis, ubi autem donum finis* (as he ſpeaks) *eſt, iba ars eſt brevis, vita verum longa, ſi arti conferatur*: 'Art 'is long, life is ſhort. But where the end is by gift, there art is ſhort, and man's 'life long, if it be compared to art.' Yet expounding the ſame words a little above, he ſaith, *Itaque Hippocrates meritò de eo conqueritur: nam & aſſeclis ipſius idem accidit: ars medica conſiſtit in philoſophia, aſtronomia, alchymia, & phyſica; meritò igitur dici poteſt artem eſſe longam. Multum enim requiritur temporis, ad quatuor has columnas medicinæ diſcendas & perſcrutandas.* 'Therefore *Hippocrates* had reaſon to make the 'complaint, for it even happened to his followers according to his words. The art 'of medicine conſiſts in philoſophy, aſtronomy, chymiſtry, and phyſicks; and 'therefore it may truly be ſaid, that the art is long: for there is much time required, 'thoroughly to learn and ſearch theſe four pillars of medicine.' *Celſus*, who hath been ſtyled *Hippocrates Latinorum*, doth more than once call phyſick a conjectural

Lib. 2. c. 6.

art, as particularly in that place, where he ſaith, *Eſt enim hæc ars conjecturalis, neque reſpondet ei plerumque non ſolum conjectura, ſed etiam experientia:* ‘ For this art is conjectural, and not only conjecture, but experience it ſelf doth not always anſwer.’ And well might theſe great men acknowledge their art to be difficult, ſince the two inſtruments (as *Galen* calls them) of finding arts, being judgment and experience, *Hippocrates* gives this character of them; ἡ δὲ πεῖρα σφαλερὴ, ἡ δὲ κρίσις χαλεπή· ‘ Experience is uncertain and fallacious, judgment is difficult to be made.’ And that experience may be uncertain without the theory of phyſick, he, that ſo much builds upon experiments, *Paracelſus* himſelf, ſeems to confeſs; where expounding the words of *Hippocrates*, he ſaith, *Hoc modo ſe habuit medicina in principio*; *ut nullam theoriam habuerit, ſed ſolum experientiam hoc laxare, hoc conſtipare, quomodo autem & cur, id ignoratum fuit: ideo unus ſalvatus eſt, alter perditus, nunc autem, &c.* ‘ And this ‘ was the faſhion of medicine in the beginning, that it had no theory, only experience, ‘ that ſuch a thing was laxative, ſuch a thing aſtringent: but how, or why they were ‘ ſo, that was not found out; and therefore one was healed, another periſhed: but ‘ now, *&c.*’ And concerning the critical part of phyſick (to allude to *Hippocrates*'s expreſſion) *Galen*, who exerciſed his reaſon ſo much about it, tells us that, *per rationem judicium haudquaquam facile exiſtit, ſed, ſi quid aliud, maximam habet difficultatem:* ‘ By reaſon it is not eaſy in a diſeaſe to give judgment, but it is as difficult as any ‘ thing imaginable.’ And to affirm the difficulty of finding the beſt way of imploying reaſon to the cure of diſeaſes, not only by the authority of *Galen*, but his arguments; let me inform you, that after having told us, how difficult a thing, and how rarely to be found is that reaſon, which conſiders, and determines what on every occaſion is to be done, *Neque enim* (adds he) *ſi veritas eſſet inventu facilis, tot ac tanti viri in ea quærenda occupati, in tam contrarias ſectas fuiſſent unquam diſpertiti:* ‘ For ‘ if the truth were eaſy to be found, ſo many and ſo excellent men, as have made it ‘ their buſineſs to find it, had never been divided into ſo many ſects and opinions.’ And *Paracelſus*, whatever he often elſewhere boaſtingly affirmeth of himſelf, yet handſomely enough both expreſſeth and confeſſeth the difficulty of being a good phyſician, in one of his *Prefaces* to the Students of Phyſick; where he ſays, *Non titulus, non eloquentia, non linguarum peritia, nec multorum librorum lectio (etſi hæc non parum exornant) in medico conſideranda, ſed ſumma rerum ac myſteriorum cognitio, quæ una facile aliorum omnium vices agit. Rhetoris quidem eſt diſertè poſſe loqui ac perſuadere, atque judicem in ſuam ſententiam trahere. Medici autem effectuum genera, cauſas ac* συμπτώματα *noviſſe, & iis inſuper ſagacitate ac induſtriâ pharmaca applicare, atque pro cujuſlibet ingenio ac ratione vel cunctis mederi:* ‘ It is not a title, nor eloquence, nor ‘ ſkill in the tongues, nor the reading of many books (though theſe are ornaments) ‘ which are to be conſidered in a phyſician; but a prime knowledge of matters and ‘ myſteries, which alone may ſtand in the ſtead of all the reſt. It is the part of a ‘ rhetorician to ſpeak eloquently, to be able to perſuade, and to draw the judge to ‘ his own party. It is the part of a phyſician to know the ſeveral ſorts of diſeaſes, ‘ their cauſes and ſymptoms, and then with ſkill and induſtry to apply medicines and ‘ to make cures of them all, according to their ſeveral natures and faſhions.’ But though, *Pyrophilus*, after the acknowledgments made by ſuch great men of the almoſt inſuperable difficulty of their art, you would perhaps think it no great preſumption, if a man ſhould attempt to innovate in any part of it, and conſequently even in the *methodus medendi:* yet, *Pyrophilus*, I am much too young, too unlearned, and too unexperienced, to dare to be dogmatical in a matter of ſo great moment. And the phyſicians are a ſort of men, to whoſe learned writings on almoſt all ſubjects, the commonwealth of learning is ſo much beholden, that I would not willingly diſſent

In præfat. lib. 1.

In Commentar. Aphoriſ. 2.

Paracelſus in his Preface to his Bertheona, or Chirurgia minor.

from them, about thoſe notions in their own profeſſion, wherein they ſeem generally to agree; and do very much diſapprove the indiſcreet practice of our common Chymiſts and Helmontians, that bitterly and indiſcriminately rail at the methodiſts, inſtead of candidly acquieſcing in thoſe manifeſt truths, their obſervations have enriched us with, and civilly and modeſtly ſhewing them their errors, where they have been miſtaken. And yet, *Pyrophilus*, ſince divers of the eminenteſt methodiſts themſelves have more than once ingeniouſly acknowledged to me, and ſeriouſly deplored with me, in the compleatneſs of their art, (which perhaps made that learned prince, the late king, tell them, that they were at beſt but good gueſſers;) and ſince about divers particular diſeaſes we have obſerved, the method of ſome of the moſt reputed doctors of *England* (which yet, I think, is as well ſtored with learned men of that profeſſion, as any part of *Europe*) not only differing, but repugnant to each other; I ſuppoſe we may, without diſreſpect to their profeſſion, diſſent from the moſt of them about thoſe caſes, about which they are reduced to diſagree ſo much among themſelves.

Inſtances to prove, that the unuſual efficacies of new remedies may alter and make the method of curing more compendious; in the king's evil.

And it would be worth an impartial diſquiſition, whether, ſince the *methodus medendi* ought to be grounded on, and accommodated to, the doctrine of diſeaſes, the new anatomical diſcoveries formerly mentioned, and others not yet publiſhed, do not, by innovating divers things in pathology, require ſome alterations and amendments in the *methodus medendi?* But in this particular, I dare yet affirm nothing; and therefore ſhall proceed to obſerve to you, that the unuſual efficacies of new remedies may probably make the method of curing more compendious, becauſe (as I lately alſo intimated) one medicine may be ſo richly qualified, as to anſwer ſeveral intentions, which, in the common way, require diverſity of helps and remedies. Thus, for inſtance, in the cure of the king's-evil; by the received method, the phyſician muſt propoſe to himſelf ſeveral ſcopes (ſuited to ſeveral indications) and proſecute them ſucceſſively with diſtinct and appropriated remedies. But I have (as I formerly alſo told you to another purpoſe) known a ſingle ſpecifick ſimple, (namely, *Paronychia folio rutaceo*) given only in ſmall beer, in not very many days, without any ſenſible evacuation, waſte the peccant humour, appeaſe the pains (which before were very great) and diſcuſs the unbroken tumours, and heal the broken ones.

Pleuriſies.

Thus, according to the known method, the great remedy in pleuriſies is copious blood-letting, which is ſtrictly preſcribed, even to aged perſons and teeming women, by the famouſeſt of our practitioners; and, I confeſs, not irrationally where the phyſician is furniſhed but with vulgar remedies: and yet by ſome Helmontian medicines, we have known pleuriſies cured even in young men, without phlebotomy, and our ſelves, ſome while ſince, made a ſucceſsful trial of that nature in a young gentleman not unknown to you: which I mention not, with *Helmont*, to reject, or ſo much as to diſparage phlebotomy in this diſeaſe, (for ſo it be moderate and ſeaſonable, experience ſhews it frequently proves uſeful) nor, as if we obſerved all *Helmont*'s boaſted remedies (though for the moſt part good ones) to be conſtantly ſucceſsful; but to give you an inſtance of the truth of what I was ſaying before, that new and more generous remedies may ſo far alter the received *methodus medendi*, as to make divers of its preſcriptions unneceſſary.

In the rickets.

Of this truth, *Pyrophilus*, another inſtance might be afforded by the rickets, a new and abſtruſe diſeaſe, at leaſt as is ſuppoſed; and ſometimes ſo ſtubborn, that one of the famouſeſt phyſicians in *Europe*, (whom I think I need not name) hath not been able of late to cure it in ſeveral of his own children. And yet, I ſuppoſe, you may have heard that excellent perſon, your mother, ſeveral times mention her having performed divers cures (ſome of them improbable enough) of this diſeaſe, barely by that ſlight preparation of colcothar, lately taught you, and preſented her by us; and by which (we having made and diſtributed, at her deſire, a conſiderable quantity of *it*) ſeveral other perſons have freed children from that disfiguring ſickneſs: of which, but few months ſince, your little couſin *D.* being almoſt paſt hope, was a while ſince brought out of danger, by God's bleſſing, upon ſome of the ſame remedy, wherewith we preſented her mother, together with our perſuaſions to try it in her own child, as ſhe had ſucceſsfully done on the children of divers others. And yet this remedy (to add that upon the by, in favour of ſomething to be ſaid anon) works almoſt inſenſibly, ſave that in many bodies it is, eſpecially at firſt, diaphoretick. And this property of that remedy minds me to add, that it would not be amiſs for phyſicians, to conſider, whether or no (however, bleeding, purging, vomiting, iſſues, glyſters, ſcarifications, and thoſe other painful ways of evacuation, be not, however chymiſts are too bitterly and undeſervedly wont to reject them, to be altogether condemned and laid aſide, yet) there may not in ſome particular diſeaſes and bodies be found more gentle, and yet effectual ways of diſcharging nature of that which offends her, than thoſe painful and debilitating ones, which we have mentioned, (without the uſe of one of the chief of which, namely, phlebotomy, we ſee that almoſt all kinds of diſeaſes are cured in children.) The contributing to render the ways of cure leſs painful and weakening, would gratify ſo great a part of thoſe, who may need phyſick, that I hope, you will eaſily pardon my ſpending ſome pages to that purpoſe. I conſider then, that oftentimes the peccant matter, though very offenſive by its qualities, is much leſſer than is ſuppoſed, in quantity, and might, if we were but maſters of ſpecifick remedies, either be breathed out by inſenſible tranſpiration, or carried off by ſweat or urine, without tormenting or weakening the patient, by thoſe other copious evacuations of groſſer matter, which are always troubleſome and painful enough, though not always eſſential. Nay, that even in chirurgery it ſelf, if thoſe, that practiſe it, were as knowing as nature has been bountiful, there would not be ſo often a neceſſity, as it is commonly ſuppoſed there is, of mutilating or tormenting the patient to recover him, you cannot doubt, unleſs you will deny what *Gulielmus Piſo* affirms, upon his own obſervation, of the cures done by the illiterate Indian empiricks. The paſſage you have ſeen already; but to it he adds ſo notable and ingenious an acknowledgement, that I cannot but honour him for it, and be willing to make way for the credibility of a good part of what we are hereafter to deliver, in this diſcourſe by premiſing it: *Immo* (continues he) *ex venenatorum fungorum aliorumque toxicorum eſu, ſolo poto infuſi recentis radicis Jaborandi in inſtanti à letho vindicatos, me aliiſque Galeni nepotibus haud parum pudore ſuffuſis, poſt tot alexipharmacorum & theriacalium antidotalium irritos conatus. Ita ut poſtea ejuſmodi collegas barbaros ſubinde mihi adjungi paſſus ſim, non adeo quidem noſtratium valetudinem ad tactum arteriarum moderari, quam dictis modis conſiliis copiam præbere ſolitos.* ‘Nay, I ſaw divers, as it were in an inſtant, redeemed from death, who had been poiſoned by the eating of venomous muſhrooms and other unwholeſome things, only by drinking a recent infuſion of the root Jaborand, whilſt my ſelf and other of *Galen*'s diſciples bluſhed to ſee the ineffectual endeavours of all our alexipharmaca, treacles, and other antidotes: ſo that afterwards I ſuffered my ſelf to be joined in conſultation with thoſe barbarous collegues, not ſo much to be arbiters of the condition of our men by their pulſe, as to give their aſſiſtance and counſel in the forementioned way, *viz.* the preſcribing of proper medicines.’ Thus far he: which premiſed, let us proceed to conſider, more particularly, ſome of the leſs painful ways of freeing men from diſeaſes.

## CHAP. X.

That great cures may be done by outward applications. Franciſcus Bernius, Donzellinus, Erneſtus Burgravius; who commend it upon their own experience, beſides very many, that commend it in general terms.

THAT great cures may be done by bare outward applications, you will ſcarce deny, if you diſbelieve not the relations, which are made us, by learned men, concerning the efficacy of the *lapis nephriticus* only, bound upon the pulſes of the wriſts (chiefly that of the left hand) againſt that ſtubborn and anomalous diſeaſe the ſtone: and that, which gives the more credit to theſe relations, is, that not only the judicious * *Anſelmus Boëtius de Boot* ſeems to prize it, but the famous *Monardes* profeſſeth himſelf not to write by hearſay of the great virtues of this Indian ſtone, but to have made trial of it himſelf upon perſons of very high quality. And that which is related by † *Monardes* is much leſs ſtrange, than thoſe almoſt incredible things, which are with many circumſtances delivered of that ſtone, by the learned chymiſt ‖ *Untzerus*. And although it muſt be acknowledged, that ſome ſtones, that go under the name, have been ineffectually applied in nephritick diſtempers, yet the accurate *Johannes de Laet* himſelf furniſheth us with an anſwer to that objection, informing us, that many of thoſe nephritick ſtones (which differ much in colour, though the beſt are wont to be greeniſh) although not at all counterfeited, or ſophiſticated, are of little or no virtue. But that yet there are ſome others of them, which can ſcarce be diſtinguiſhed from the former, but by trial upon nephritick perſons, which are of wonderful efficacy; as he himſelf hath more than once tried in his own wife. *Garcias ab Orto* (Lib. 1. cap. 53.) mentions a ſtone, found in *Balagat*, called *Alaqueca*; of which he tells us, that though it be cheap, *Hujus tamen virtus* (to uſe his own words) *reliquarum gemmarum facultates exuperat, quippe qui ſanguinem undiquaque fluentem illico ſiſtat.* 'The virtue of this ſtone is much above that of any other gems; for it ſtops 'the flux of the blood in any part.' *Monardes* (cap. 35.) relates the great virtues of a ſtone againſt hyſterical ſuffocations, and concludes, *Cum uteri ſuffocationem imminentem præſentiunt, adhibito lapide ſubito levantur, & ſi eum perpetuo geſtant (hyſterici) nunquam ſimili morbo corripiuntur, exempla hujuſmodi faciunt, ut his rebus fidem adhibeam.* 'When the women perceive a fit of the mother coming upon them, by 'applying this ſtone they are immediately eaſed; and if they always wear it, they are 'never troubled with thoſe fits more. Of this they make faith, by many inſtances.' The ſame author, in the next chapter, treating of the *lapis ſanguinaris*, or bloodſtone, found in new *Spain*, (having told us, that the Indians do moſt confidently believe, that if the fleſh of any bleeding part be touched with this ſtone, the bleeding will thereby be ſtanched) adds this memorable obſervation of his own; *Vidimus nonnullos hæmorrhoidum fluxu afflictos remedium ſenſiſſe, annulos ex hoc lapide confectos in digito continue geſtando; nec non & menſtruum fluxum ſiſti.* 'We have ſeen ſome, that were 'troubled with the flux of the hæmorrhoids, who found remedy by wearing rings 'made of that ſtone continually on their fingers, and the monthly flux is ſtaid by the 'ſame way.' And of the formerly mentioned *lapis porcinus*, the experienced *Bontius* (having mentioned how the Indians give the wine, wherein it hath been ſteeped, againſt the diſeaſe called *Cholera*; which is as much, and as juſtly feared, by the iſlanders of *Java*, as the plague is in *Holland*) adds this memorable paſſage: *Prægnantibus tamen hic lapis non bene datur; nam abortum provocare adeo certum eſt, fœminæ Malaicæ mihi retulerint, ut ſi quando menſtrua eorum purgatio non bene procedat, ſi ſaltem hunc lapidem manu geſtent, juvamentum ſe inde ſentire.* 'This ſtone is not proper for

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* *De Lapid. & Gem.* Lib. 2. cap. 11. † *Nicolaus Monardes de ſimplic. Ind. Hiſt. è ſeu tit.* 20.

‖ *De Nephrit.* Lib. 1. c. 24. where he hath nine or ten *Obſervationes raræ & inauditæ de Lap. Nephritico.* Of the efficacy of *Lapis Nephriticus* and other *appenſa. De Gem. & Lapidibus,* Lib. 1. c. 23.

‘ thoſe, who are with child, for it is ſo ſure to cauſe abortion, that the women of ‘ *Malaica* told me, that if at any time their monthly evacuations were obſtructed, ‘ that if they only carried this ſtone in their hands, they found remedy thereby.’ And the relations, *Pyrophilus*, that I may in another place preſent you with, concerning the wonderful ſtone, formerly mentioned, with which your grandfather performed ſuch eminent cures, (particularly of the ſtone, in the Lord of *Falkland*, then deputy of *Ireland*, and others, to whoſe backs it was applied) will, I ſuppoſe, make you the more readily give credit to the relations of the authors we have newly mentioned. What *Monardes* mentions of the virtue of the *lapis ſanguinaris*, to cure hæmorrhoidal fluxes, puts me in mind of a yet much ſtranger thing, which *Helmont* affirms; namely, that he could make a metal, of which if a ring were worn, the pain of the hæmorrhoids would be taken away, in the little time requiſite to recite the Lord's prayer; and within twenty four hours the hæmorrhoids themſelves, as well internal as external, how protuberant ſoever, would vaniſh, and the reſtagnant blood would (as he ſpeaks) be received again into favour, and be reſtored to a good condition. The ſame ring he alſo commends in the ſuffocation and irregular motion of the womb, and divers other diſeaſes: but if *Paracelſus* be in any caſe to be credited in an unlikely matter, we may think, by his very ſolemn proteſtations, that he ſpeaks upon his own experience, that he had a ring made of a metalline ſubſtance, by him called *electrum*, (which, by his deſcription, ſeems to be a mixture of all the metals joined together under certain conſtellations) which was of a far greater virtue than this of *Helmont*; for *Hoc loco* (ſays he) *non poſſum non indicare admirandas quaſdam vires virtuteſque electri noſtri, quas fieri his noſtris oculis videmus, adeoque cum bona veritatis conſcientia proferre atteſtarique poſſumus. Vidimus enim hujus generis annulos, quos qui induit, hunc nec ſpaſmus convulſit, nec paralyſis corripuit, nec dolor ullus torſit, ſimiliter nec apoplexia, nec epilepſia invaſit. Et ſi annulus hujuſmodi epileptici digito annulari, etiam in paroxyſmo ſæviſſimo, incertus fuit, remittente illico paroxyſmo, æger à lapſu illico reſurrexit, &c.* ‘ In this place I cannot but relate the admirable virtues of our electrum, which ‘ I have obſerved with my own eyes, and therefore can atteſt with a good conſcience. ‘ For we ſaw rings of it, which he that wore neither felt cramp, nor palſy, nor other ‘ pain. He was ſubject to no fits of apoplexy, nor epilepſy, inſomuch that if one of ‘ theſe rings were put upon the ring-finger of a perſon actually in any vehement fit of ‘ the falling ſickneſs, that fit would immediately aſſuage, and the perſon as ſoon ‘ come to himſelf.’ But to take notice of ſome other outward remedies. To our preſent theme belongs that noble cure, performed by the famous and experienced *Fabricius ab Aquapendente*; who tells us, that he cured a man of a *ſchirrus lienis*, and a dropſy, by the long uſe of ſponges, moiſtened with common lime-water, and then expreſſed and worn upon the ſpleen; notwithſtanding the muſcles of the abdomen, and all the other parts, that lie betwixt the applied ſponge and the part affected. And to this we may add the ſtrange cures mentioned by *Kircherus*, and confirmed to me by a learned eye-witneſs, to be frequently performed, of very dangerous diſeaſes, in that cave near *Rome*, where the patient being expoſed ſtark naked, and tied hand and foot upon beds of ſtraw; and being by the ſulphureous vapour of the place, and ſometimes their own fear, caſt into a ſweat, are licked well by a great number of peculiar kind of ſerpents that inhabit that grotto. Moreover, we oftentimes ſee agues cured by amulets and applications to the wriſts, and I myſelf was, about two years ſince, ſtrangely cured of a violent quotidian, which all the wonted method of phyſick had not ſo much abated, by applying to my wriſts a mixture of two handfuls of bay-ſalt, two handfuls of the freſheſt Engliſh hops, and a quarter of a pound of blue currants, very diligently beaten into a brittle maſs, without the addition of any thing moiſt,

Helm. de Febr. c. 2.

Paracelſ. in Archidox. Magic. lib.

De operat. chirurg. p. 1. c. 15.

The cures of the dropſy and ſcirrhus lienis by the external application of ſponges dipt in lime-water.

Of ſtrange cures performed near Rome in the ſerpentine grotto.

moiſt, and ſo ſpread upon linen cloth, and tied about the wriſts. And with the ſame remedies (which yet we have obſerved ſometimes to fail) have divers others been cured, both of quotidian and tertian agues: nay, an eminent phyſician gave me, lately, thanks, for the great effects he had found of it, even in continual fevers.

Of the operations of ſulphur, cantharides, quick ſilver, and tobacco externally applied.

AND here, *Pyrophilus*, I ſhall not ſcruple to acquaint you with my having ſometimes wiſhed, that phyſicians had been a little more curious to make obſervations and trials of the diſtinct operations of various bodies outwardly applied. For I conſider, that, in ſome of them, the ſubtile corpuſcles, (which ſeem to inſinuate themſelves into the pores of the body, and into the maſs of blood, with little or no alteration) have much the like operations with the body, whence they exhale, taken in at the mouth. As we ſee in ſome preparations of ſulphur, which have like virtues, inwardly given, and outwardly applied; and more manifeſtly in *Cantharides*, which I have found, by external application, to work ſtrangely upon the bladder, as that they excoriated it when taken into the body; and yet more manifeſtly in quick-ſilver, which by inunction may be made as well to ſalivate, as if it were ſwallowed down. And an eminent phyſician lately complained to me, that waſhing a child's ſcabby head with a decoction of tobacco, to kill and dry up the ſcabs, the boy was made thereby both ſick and drunk. And learned men aſſure us, that by ſome cathanticks outwardly applied, thoſe may be purged, that will not ſwallow phyſick. But other medicines there are, which, before they get into the maſs of blood, are much altered, either in ſtraining through the fleſh and membranes of the body, or in the digeſtions they paſs through in the ſtomach, and elſewhere. And theſe may have very differing effects, inwardly given, and outwardly applied; as in the formerly mentioned inſtance of hops, currants, and ſalt, neither any of the ingredients inwardly given, nor the mixture hath been (that I know of) noted for any febrifugal virtues. So likewiſe turpentine and ſoot, that inwardly taken are good for quite other diſeaſes, (as pleuriſies, and obſtructions of the kidneys) outwardly applied are the main ingredients of pericardiums, extolled againſt agues. And millefolium or yarrow, beſides the virtues it hath inwardly againſt diſeaſes of quite other natures, being worn in a little bag upon the tip of the ſtomach, was (as himſelf confeſt to me) the ſecret againſt agues, of a great lord, who was very curious of receipts, and would ſometimes purchaſe them at very high rates. And a very famous phyſician of my acquaintance did ſince inform me, that he had uſed it with ſtrange ſucceſs. I know alſo a very happy phyſician, who aſſures me, that he hath very often cured, both in himſelf and others, the chilblains, when they come to be broken, by barely ſtrowing on the ſore parts the fine powder of quinces thinly ſliced and dried. And who knows, what unexpected operations divers other bodies may have, when outwardly applied, if various trials of that nature were ſkilfully made; eſpecially ſince we ſee, that (for reaſons elſewhere to be conſidered) ſome bodies ſeem to have quite contrary operations, when outwardly applied and inwardly taken? For we ſee, that ſpirit of wine does, in ſeveral caſes, allay the inflammation of the external parts, which given inwardly would quickly inflame the body. And our often commended *Piſo*, ſpeaking of a choice remedy for thoſe diſtempers of the eyes, that uſed to trouble men in *Braſil*, adds, *Idem quoque præſtat maniphera, ex radice mandiboca, quæ licet pota venenoſa habeatur* (as we formerly noted out of his and other teſtimonies) *oculis tamen prodeſt, viſumque emendat.* And if the ſimples, to be outwardly applied, be ſkilfully prepared, that may much vary and improve their operations. As we ſee, that vitriol, which is made of copper, or iron corroded by, and coagulated with acid ſalts, hath outwardly divers virtues, which crude copper has not either outwardly or inwardly. And gold diſſolved in aqua regis, and

Inſtances in divers medicines, which have differing effects inwardly given, and outwardly applied.

That preparation may much improve ſimples, which are outwardly applied.

Inſtances in divers preparations of gold.

An ointment made of aurum fulminans for the hæmorrhoids and venereal ulcers.

and precipitated with oil of tartar, is inwardly, as far as I can diſcover, gently purgative; yet the ſame *aurum fulminans* being calcined with twice or thrice its weight of flowers of brimſtone, till the *flores* be burnt away, is known to be much commended by chymiſts, and others, for a diaphoretick. But though, as to any outward virtues of the ſame powder, phyſicians and chymiſts are wont to be ſilent, yet probably it may have very great ones, as well as quite differing from thoſe it has, being taken at the mouth. For I know a perſon, that being grievouſly tormented with exulcerated hæmorrhoids, a very expert chymiſt of my acquaintance, not knowing what elſe to do, applied to the part affected an ointment conſiſting only of *aurum fulminans*, prepared and fixed by a ſlight and familiar way (which you may command) and made up with a little oil of ſweet almonds into a requiſite conſiſtence; and though preſently upon the application of the remedy, the pain for a quarter of an hour hugely increaſed, yet ſoon after it abated, and the hæmorrhoids the next day were cloſed, and the day after went away; nor has the patient ever ſince (that is, for ſome years) been troubled with any thing of relapſe. And the ſame phyſician aſſures me, that with the like remedy he has found a ſtrange effect in venereal ulcers. And perhaps to this may be referred what has been found by ſome friends of mine, that phlegm of vitriol, and *ſaccharum Saturni*, which not only inwardly given are ſaid much to cool the blood, but outwardly applied are good for burns and hot humours, do yet potently diſcuſs cold tumours. But leſt you ſhould ſay, that this diverſity may proceed (at leaſt in part) from the corpuſcles of differing natures, that may be imagined in the forementioned medicines; I ſhall return to what I was diſcourſing of before, and take notice of the efficacy of ſome other external remedies.

The cure of a perſon eſteemed bewitched, by an appended mineral.

[SINCE the beginning of this eſſay, I ſaw a luſty and very ſprightful boy, child to a famous chymical writer, who, as his father aſſured me and others, being by ſome enemies of this phyſician's, when he was yet an infant, ſo bewitched, that he conſtantly lay in a miſerable torment, and ſtill refuſing the breaſt, was reduced, by pain and want of food, to a deſperate condition, the experienced relater of the ſtory remembering, that *Helmont* attributed to the *electrum minerale immaturum Paracelſi* the virtue of relieving thoſe, whoſe diſtempers come from witchcraft, did, according to *Helmont*'s preſcription, hang a piece of this noble mineral about the infant's neck, ſo that it might touch the tip of the ſtomach; whereupon preſently the child, that could not reſt in I know not how many days and nights before, fell for a while aſleep, and waking well, cryed for the teat, which he greedily ſuckt, from thenceforth haſtily recovering, to the great wonder, both of his parents, and ſeveral others, that were aſtoniſhed at ſo great and quick a change. And though I am not forward, to impute all thoſe diſeaſes to witchcraft, which even learned men father upon it; yet it is conſiderable in our preſent caſe, that whatſoever were the cauſe of the diſeaſe, the diſtemper was very great and almoſt hopeleſs, and the cure ſuddenly performed by an outward application, and that of a mineral; in which compacted ſort of bodies, the finer parts are thought to be more locked up.]

The power of the jaſper to ſtanch blood.

De Lapid. & Gem. l. 2. cap. 102.

AMONG the proofs of the efficacy of appended remedies, we muſt not pretermit the memorable examples, that are delivered by the judicious *Boetius de Boot*, concerning the virtues of that ſort of jaſper, which is blood-red throughout the whole body of the ſtone, not being mingled with any colour: *Teſtari poſſum* (ſays he) *me, qui alias lapidibus & gemmis tantas vires, quantas vulgus ſolet, non tribuo, credibile vix, de jaſpidis viribus, obſervaſſe. Nam cum ancilla fluxu menſtruorum ita laboraſſet per aliquos dies, ut nullo modo ſiſti poſſet, jaſpidem rubram impolitam & rudem femori alligari juſſi. Alius (in eadem domo) cum in pede vulneratus eſſet, nec ſanguinis fluxus cohiberi poſſet, admoto lapide, extemplo impeditus fuit, licet vulnus non tegeretur.* To theſe he adjoins a much more memorable example, of a maid he cured at *Prague*, who had been for ſix years ſick of an hæmorrhagy ſo vehement, that there ſcarce ever paſt a week, in which ſhe did not ſeveral times bleed, neither could ſhe be relieved by any remedies, though ſhe had long uſed them, till ſhe was quite tired with them: wherefore our author ſetting them aſide, lent her a jaſper, of whoſe virtue in ſuch caſes he had made good trial, to hang about her neck, which when ſhe did, the flux of blood preſently ceaſed, and ſhe afterwards, for curioſity ſake, oftentimes laying aſide the ſtone, and, as often as ſhe needed it, applying it again, obſerved, that whereas the flux of blood did not preſently return upon the abſence of the jaſper, but after divers weeks, yet upon the hanging it on again it would preſently be ſtopt; ſo that ſhe could not aſcribe the relief to any thing but the ſtone, by which our author tells, that at length ſhe was quite cured. And ſpeaking of the praiſes given by others to green jaſper ſpeckled with red, he concludes, *Sed ego, quod multoties expertus ſum, refero.* But amongſt the operations of outwardly appended medicines, I have ſcarce met with a ſtranger than that, which the experienced *Henricus de Heer* mentions in the fourteenth of thoſe obſervations which he truly ſtiles rare, namely, that a woman, who had by an unſkilful midwife the bladder lacerated, and thereby been ſubject to a perpetual *incontinentia urinæ*, and had been reduced conſtantly to wear a ſilver pipe, was perfectly helped, by wearing, as a gipſy had taught her, a little bag hung about her neck, containing the powder made of a live toad, burnt in a new pot. Which relation I the rather mention, not only becauſe the author having tried the remedy upon a merchant, to whom an unſkilful lithotomiſt had left the like diſeaſe, found it preſently to ſucceed; but becauſe having been very deſirous to have further trial made of ſo odd a remedy, by a curious phyſician, he lately gave me this account of it, that though in one or two it had failed, yet having given ſome of the powder to an exquiſite perſon, known to us both, he aſſured him it had ſucceeded in two or three. (And the diſeaſe is too unfrequent, to give occaſion to have the remedy often tried.) And the phyſician adds, that one of thoſe patients tells him (the phyſician) that though her infirmity were occaſioned by a *laceratio veſicæ*, yet the remedy helps her, as long as ſhe wears it about her, in caſe ſhe renew the powder, when the virtue of it begins to decay; but that (which is remarkable to our preſent purpoſe) if ſhe leaves it off a while, ſhe finds the diſeaſe return. The ſame *Henricus ab Heer*, among his freſhly commended obſervations, has another of a little lady, whom he concludes to have been caſt into the ſtrange and terrible diſtemper, which he there particularly records, by witchcraft. Upon ſo ſevere an examination of the ſymptoms made by himſelf, in his own houſe, that if, notwithſtanding his ſolemn profeſſions of veracity, he miſ-relate them not, I cannot but wonder he ſhould confidently impute ſo prodigious a diſeaſe to ſome ſupernatural cauſe. But though the obſervation, with its various circumſtances, be very well worth your peruſing; yet that, for which I here take notice of it, is, what he adds about the end of it, concerning his having cured her, after he had in deſpair of her recovery ſent her back to her parents, by an outward medicine, namely, an ointment, which he found extolled againſt pains produced by witchcraft, in a Dutch book of *Carrichter*'s: (where alſo I remember I met with it, ſet down a little differing from what he delivers.) Of which wonderful ointment, the ingredient that he found ſo extremely difficult to procure, namely, the miſletoe of hazel, being in *England* not ſo rare, but that I have more than once got it, and found, as he intimates, very green, and (what he mentions not) extremely bitter, I could wiſh, that thoſe, that have the opportunity, would make trial. For beſides what *Carrichter* delivers, and our author relates of it, a learned phyſician did highly commend it to the judicious *Gregorius Horſius*. And though if we allow it to cure bewitched

In Obſerv. Medic. oppido rariſ. p. 194. The incontinentia urinæ cured by the powder of a toad burnt alive, and hung about the neck.

Effects aſcribed to witchcraft, cured per appenſa.

bewitched patients, the virtue, that may be in external remedies, will be made ſo much the more conſpicuous; yet ſuppoſing the diſeaſes to be, though ſtrange, yet but natural, we cannot but allow, that there may be a wonderful efficacy in an outward remedy, ſince it was able, only by anointing the joints, and thoſe pained parts with it, to cure a radicated diſeaſe, attended with ſuch wonderful and horrid ſymptoms. And after this it may ſeem but little, what elſe would appear a ſtrange thing, which *Helmont* affirms of a plaiſter he had, wherewith he tells us, that he ſafely cured hundreds of quartans, even autumnal, without relapſe: elſewhere he ſaith, that he made his plaiſter (for by the circumſtances I preſume he means no other) of a few reſolving and abſterſive things, and adds, that it never failed him, but only that in fat perſons it ſucceeded more ſlowly. And yet in theſe, and the like ways of curing diſeaſes, though approved, if not alſo commended, by eminent phyſicians both ancient and modern, there is no ſenſible evacuation made of peccant humours, which perhaps materially remain in the body, and may, by the effluvia of theſe remedies, be deprived of their former qualities, and made ſo far obſequious to nature, that ſhe is able, if need be, to eaſe her ſelf of them by ſweat, urine, or undiſcerned tranſpiration.

Helmont cured quartans by a plaiſter.

Helmont. de Febr. cap. 14. verſ. finem.

Cap. 17. in fine.

AND that the peccant humours remain for a while materially in the body (the diſeaſe ſometimes being removed) may appear by the cures, which we ſee now and then performed of agues by ſudden frights; by which no diſcernible evacuation is made of humours, though probably ſome conſiderable change be thereby produced in the temper of the maſs of blood, or in the texture of the morbifick matter (as phyſicians call it;) as ſeems probable, both from divers other things mentioned here and there in this eſſay, and particularly from the lately recited paſſage of *Helmont*, where he takes notice of the rectifying of the peccant, and by nature rejected blood, without any ſenſible evacuation, upon the wearing of his ring. I knew a gentleman, a ſtrong and reſolute man, who had been long a ſoldier, and attained the higheſt ſort of military imployments; notwithſtanding which, he was ſtrangely fearful of rats, and could not endure the ſight of them: this gentleman having been long troubled with an obſtinate quartan, and travelled with it into ſeveral countries, without being able to find any cure for it, coming at length accidentally and ſuddenly into a place, where a great rat was in a corner, whence he could not fly from the gentleman, he furiouſly leaped upon him (yet without biting him) and thereby putting him into a fright, which freed him from the ague, that long had importuned him. And the experienced *Salmuth* tells us, in a pleaſant obſervation, of one, who was cured even of the gout by a fright. For this man having his feet and hands covered with a poultis, made of turneps, flour and milk, and being left in his chair in a low room, was, whilſt his ſervants were all gone into the garden, aſſaulted by a ſow, who finding the door open, and invited by the ſmell of the cataplaſm, came to devour it; and ſtriving to do ſo, flung the ſick man and the chair to the ground, and put him into ſuch a fright, that our author tells us, that very day his pains decreaſed, and continued leſſening by degrees, till at length they wholly left him, without ever returning to trouble him again. There are divers inſtances, that diſcover what great changes may be produced in the body, without taking in any thing viſibly at the mouth. And on the other ſide, a good air alone doth often, in conſumptions and other diſeaſes, perform what hath in vain been expected from the uſe of emptying phyſick. It were to be wiſhed, that we had, among our European phyſicians, the phyſick books of thoſe of *China*; for though our doctors are much more learned men than theirs, yet probably their writings and their practice may teach us ſomething that is new, and ſomething making for our preſent purpoſe. For the famous Jeſuit *Semedo* informs us, that

Diſeaſes cured by frights.

Obſerv. Cent. 1. Obſerv. 48.

Phyſick now in China is in a good condition without phlebotomy, potions, or iſſues. Hiſt. of China, Part 1. chap. 12.

[N. B.]

Where practitioners of phyſick are illiterate, the ſpecificks may be beſt met with.

Galen. aphor. Hipp. comment. 1. The Uſefulneſs of the knowledge of the medicines of barbarous nations.

Lib. 2. Dialog. 7.

that the books of our phyſicians having not yet been brought to *China*, they are inſtructed in their art by abundance of their own writings; and that though in their practice they do not let blood (as the learned * *Varenius* tells us, that neither do the Japonian doctors) or ſet cupping-glaſſes, though they uſe no ſyrups, nor potions, nor any iſſues, but are herbaliſts, uſing nothing but herbs, roots, fruits, ſeeds, *&c.* yet phyſick (to uſe our author's words) *is in a very good condition in* China, (as *Almeida* alſo tells us, that the phyſicians are much eſteemed in *Japan*;) and of the ſkill of ſome of the Chineſes in that art, he gives us in the ſame chapter ſome conſiderable inſtances. And though, as we ſaid, it is very likely, that their doctors are much inferiour in point of learning to ours; yet it is conſiderable, that in ſo vaſt, ſo civilized, and ſo populous a country, phyſick can be practiſed with reputation, without the uſe of thoſe evacuations, which are here ſo frequently made in phlebotomy, potions and iſſues. Nor ſhould we only expect ſome improvement to the therapeutical part of phyſick, from the writings of ſo ingenious people as the Chineſes; but probably the knowledge of phyſicians might be not inconſiderably increaſed, if men were a little more curious to take notice of the obſervations and experiments, ſuggeſted partly by the practice of midwives, barbers, old women, empiricks, and the reſt of that illiterate crew, that preſume to meddle with phyſick among our ſelves; and partly by the Indians and other barbarous nations, without excepting the people of ſuch part of *Europe* it ſelf, where the generality of men are ſo illiterate and poor, as to live without phyſicians. For where phyſick is practiſed by perſons, that never ſtudied the art of it in ſchools, or books, many things are wont to be raſhly done, which, though perhaps prejudicial, or even fatal to thoſe, on whom they are tried, may afford very good hints to a learned and judicious obſerver: beſides, where the practitioners of phyſick are altogether illiterate, there oftentimes ſpecificks may be beſt met with. For ſuch perſons being wont, for want of ſkill in phyſick, and particularly the art of mixing ſimples, and in that of varying their remedies according to circumſtances, do almoſt wholly rely upon ſpecificks; whoſe virtues, from their practice, may be ſometimes better gathered, than from that of ſkilful phyſicians, in regard that thoſe empiricks (beſides that they aſſiſt not with any ſkill in the *methodus medendi* the virtues of their remedies) are wont, for the reaſons newly mentioned, to try obſtinately, and to the uttermoſt, the effects of their few ſpecificks. And the nature of their medicines may be the better known, in regard they are not wont to blend them, as learned men but too often do, with many other ingredients, whoſe mixture, as we formerly noted, either alters their nature, or makes it difficult to determine (as *Galen* himſelf in a like caſe confeſſeth, *Nam, ut verum fateamur, hæc difficilis quoque res eſt & rara inventu, cùm poſt multa remedia adhibita ægrotanti, quod ex iis in cauſa fuiſſe dicitur, ut melius pejuſve habeat)* whether the effect be aſcribed to what is given for the ſpecifick, or to ſome other of the ingredients, or to the whole compound as ſuch. The experienced *Bontius*, in his excellent little tract *de Medicina Indorum*, doth more than once confeſs, that it is very undeſervedly, that the Europeans look upon the Eaſt-Indians as Barbarians. And even of thoſe among them, that are ignorant of other things, he hath this paſſage; *Hinc etiam ſit, quod homines cæteris rebus idiotæ tam exactam herbarum & ſtirpium nanciſcantur ſcientiam, ut ſi vel doctiſſimus Pavius, noſtri ævi botanicorum princeps, è mortuis reſurgens huc veniret, miraretur ſe ab hiſce hominibus barbaris doceri*

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* *Medicinæ faciendæ mediocrem habent peritiam. Ægris ſalſa, acria, & plura proponunt, dicente Matſeo, piſces & conchylia pharmaca ſuavia & odorata.* [*N. B.*] *Sanguinem nunquam eliciunt. Magnam medicorum dignitatem videre eſt ex Epiſtola Almeidæ, ubi narrat, &c.* Bern. Varenius, in Deſcript. regn. Japo... cap. 25.

*poſſe.* And *Linſchoten* in his voyages, ſpeaking of that famous mart of the *Eaſt-Indies*, the city of *Goa*, where the Viceroy and Archbiſhop reſided, and he himſelf lived: Theſe heatheniſh phyſicians, ſaith he, (mentioning thoſe of *Goa*) do not only cure their own nations and country-men, but even the Portugals alſo; for even the Viceroy himſelf, the archbiſhop, and all the monks and friars, do put more truſt in them than in their own countrymen, whereby they get great ſtore of money, and are much honoured and eſteemed. I have not now the leiſure to acquaint you with what I might alledge, to confirm this truth out of the practices of the illiterate natives of ſome not yet ſufficiently civilized part of *Ireland*, and the inhabitants of ſome other places, where phyſicians have not yet ſettled: but I ſhall mind you of the confeſſion of *Celſus*, where ſpeaking of phyſick, *Hæc nuſquam* (ſaith he) *non eſt: ſiquidem etiam imperitiſſimæ gentes herbas aliaque prompta in auxilium vulnerum morbumque noverunt.* And I wiſh, that other learned men would imitate the commendable example, not only of *Proſper Alpinus*, who wrote a treatiſe *de Medicinâ Ægyptiorum*, and of *Jacobus Bontius*, in his *Medicina Indorum*, but of *Gulielmus Piſo*, who hath lately preſented the world with the rude way of curing, uſed by the Braſilians themſelves, in his new and curious books *de Medicina Braſilienſi*, in the beginning of the ſecond of which, he much confirms what we have been delivering, in the enſuing paſſage: *Quemadmodum multa in tam craſſa Barbarie cruda vel corrupta arteque hippocraticâ indigna reperiuntur, ſit etiam non pauca utiliſſima antiquitatem redolentia, quæ vel eruditiſſimos medicos ad urnas medicinæ ſubjiciunt, obſervanda occurrunt. Quippe cum multarum artium rudimenta vel ab ipſis animantibus brutis (quibus benigna mater natura arte inſita imprimis curandis morbis deſtitui noluit) ad nos redundare fatendum ſit; quis dubitet ab his mortalibus, licet remotiſſimis à dogmaticâ & rationali medendi arte, non plurima nobiliſſima at ſecreta remedia atque antidota, medendi morbos veteribus incognitos quotidiè ad poſteros derivari? quibus paulatim ad manum traditis, & tandem quaſi in ſuccum & ſanguinem à rationalibus converſis doctorum ſcholæ & libri ſuperbiunt?* And to this agrees very well that grave ſaying of our experienced *Harvey*, to the very learned Doctor *Ent*: *Nulla gens tam barbara eſt, quæ non aut fortuitò, aut inevitabili quadam neceſſitate coacta, aliquid in uſum communem adinvenerit, quod nationes alias humaniores latuit.* Nor ſhould we diſdain the remedies of ſuch illiterate people, only becauſe of their being unacquainted with our theory of phyſick. For though I will not ſay, as the old empiricks wittily enough did in that paſſage of *Celſus*, *Requirere etiam, ratio idem doceat quod experientia, an aliud? Si idem, ſupervacuum eſſe, ſi aliud, etiam contrarium.* But leſt we ſhould by too great reliance on the Galenical, or other ancient opinions, neglect uſeful remedies, becauſe preſented by perſons, that ignore them, and perhaps too hold opinions contrary to them; I ſhall leave you to conſider, what is in the perſon of the ſame empirical ſect, repreſented by *Celſus*, where having ſpoken of the darkneſs of the cauſes of things, and the uncertainty of the theorems of phyſick: *Ac nihil iſtas cogitationes* (ſaith he) *ad medicinam pertinere, eo quoque diſci, quod qui diverſa de his ſenſerint, ad eandem tamen ſanitatem homines perduxerint. Id enim feciſſe, quia non ab obſcuris cauſis neque à naturalibus actionibus, quæ apud eos diverſæ erant; ſed ab experimentis, prout cuique reſpondeant, medendi vias traxerint, ne inter initia quidem ab iſtis quæſtionibus deductam eſſe medicinam, ſed ab experimentis, &c.* For though this ſentence aſcribes too little to reaſon, yet there is ſomething in it, that deſerves to be conſidered; eſpecially ſince we obſerve not, that the late anatomical diſcoveries of the motions of the chyle and lymphatick liquor, by formerly unknown ways, in newly detected veſſels, hath yet made men cure diſeaſes much better than before. Not that I think, that anatomical and pathological diſcoveries will not, in proceſs of time (when the *hiſtoria facti* ſhall be fully and indiſputably made out, and the theories thereby ſuggeſted, clearly eſtabliſhed)

Voyage, c. 34.

Preface, lib. 1.

Piſo de Medic. Braſil. lib. 2. c. 1.

Georg. Ent. in Epiſtol. præfix. Exercit. Harvei de gen. animal.

Celſi præfatione ad Lib. 1.

A compariſon of the empirick part of phyſick with the rational.

eſtabliſhed) highly conduce to the improvement of the therapeutical part of phyſick; but yet this obſervation may make it the more reaſonable to beware of relying ſo much upon the yet diſputable opinions of phyſicians, as to deſpiſe all practices, though uſually ſucceſsful, that agree not with them: for of ſuch our author ſpeaks well, *In omnibus ejuſmodi cogitationibus in utramque partem diſſeri poſſe, itaque ingenium & facundiam vincere: morbos autem non eloquentiâ ſed remediis curari; quæ ſi quis elinguis uſu diſcreta benè norit, hunc aliquanto majorem medicum futurum, quam ſi, ſine uſu, linguam ſuam excoluerit.* And *Paracelſus* ſpoke well too, if he ſpoke truly, when in one of his prefaces, ſpeaking to thoſe, whom he invited to hear him expound his books of phyſick and chirurgery at *Baſil*; *Illos tamen* (ſaith he of his formerly mentioned books) *non aliorum more ex Hippocrate aut Galeno, aut quibuſlibet emendicatos, ſed quos ſumma rerum doctrina, experientia atque labore aſſequutus ſum, proinde ſi quid probaturus, experimenta, ac ratio, auctorum loco, mihi ſuffragantur.*

Petrus de Oſma in epiſt. ad Monard. quæ extat in libello de ſimplicibus medicamentis ex Occidentali India delatis.

IT would, *Pyrophilus*, I fear, be tedious to trouble you here with all, that I have met with in good authors, applicable to my preſent ſubject, and the deſign I have been proſecuting in favour of external remedies: but yet one paſſage there is, which doth ſo notably confirm what we have delivered, as well touching the efficacy of ſimple medicines, as the great cures, that may, in divers caſes, be performed by outward applications, that I muſt not here omit the mentioning of it; as I find the epiſtle written out of *Peru* to the inquiſitive *Monardes*, in theſe words: *In urbe Poſto, ubi aliquot annis vixi, omnis generis morbos Indus quidam curabat ſolo cujuſdam plantæ ſucco artubus & parti affectæ illito. Ægros deinde ſtragulis egregiè tegebat ad ſudorem provocandum: ſudor è partibus illitis emanans merus ſanguis erat, quem linteis pannis abſtergebat, atque ita in curatione pergebat, donec ſatis ſudaſſe putaret, optimis interea cibis eos alens. Eo remedio multi morbi deplorati curabantur, imo ægri juniores & robuſtiores ab ejus uſu fieri videbantur, ſed neque pretio, neque precibus, neque minis unquam efficere potuimus, ut eam plantam nobis demonſtraret:* ‘In the city *Poſto*, where ‘I lived certain years, a certain Indian cured all ſorts of diſeaſes by the juice of one ‘plant alone, wherewith he anointed the limbs and any other part particularly affected, ‘and then covering them warm with blankets, provoked ſweat. The ſweat, that ‘came from the part ſo daubed, was meer blood, which he wiped off with linnen ‘cloths, and ſo he proceeded until he thought they had ſweat enough. In the mean ‘time he gave them diet, that was moſt nouriſhing. With this remedy many deſ‘perate diſeaſes were cured, and the ſick perſon upon the uſe of this phyſick im‘proved, ſo as to appear younger and luſtier after it. But we could never prevail, ‘neither by money, nor intreaty, nor foul means, upon him to ſhew us the plant.’

## CHAP. XI.

Of other extraordinary medicines, which work by magnetiſm, tranſplantation, &c.

BUT, *Pyrophilus*, beſides ſuch external medicines, as work after the manner of thoſe I have heretofore mentioned, we may poſſibly without abſurdity, provided we do it without credulity, inquire, whether there may be yet a ſort of others, that operate in a more wonderful and extraordinary way? And it would not perhaps be altogether unworthy the experiment, to try, whether or no there may not ſometimes be performed, ſuch cures, as are wont to paſs either for fabulous or magical; ſome of them being to be done without exhibiting, or applying any thing immediately to the patient, and others by ſome ſuch unknown ways as thoſe, which chymiſts call, either magnetiſm, or tranſplantation: ſuch as are the cures reported to be performed by the weapon-ſalve and ſympathetick powder, and ſuch as is that cure of the yellow jaundice (mentioned with ſome verification by *Paracelſus*) wherein ſeven or nine cakes (for it muſt, forſooth, be an odd number) are made up with the newly emitted and warm urine of the patient, and the aſhes of aſhwood, and buried for ſome days in a dunghill. For it is not only by the eaſy and ſuperſtitious vulgar, that the poſſibility of performing ſuch cures, by tranſplantation, or ſome other magnetical way (as they pleaſed to call it) hath been believed. For within the compaſs of my own ſlender reading, I find, that divers eminent phyſicians have both made uſe of, and commended magnetical remedies.

The cure of an ulcer in the bladder by ſympathetick powder.

WHAT is to be thought of the ſympathetick powder, I confeſs I am as yet in doubt; but however I ſhall take this occaſion to inform you, that a very honeſt gentleman, whom his pen has made known to a great part of the learned men and virtuoſi in *Europe*, complaining often to me, that though he were much troubled with that ſad diſeaſe, the ſtone in the bladder, yet he was more inceſſantly tormented with an ulcer he had in the ſame part, (all the ſearching medicines, that he took to diſſolve, as he hoped, the ſtone, exaſperating the ulcer:) I one day adviſed him to make uſe of the powder of ſympathy, upon ſome of the ulcerous matter he voided with his urine; the remedy being ſuch, as, if it had a magnetick virtue, might do him good; and if it had none, could not prejudice him. A while after, I received, both from him in a letter, and from his phyſician, very great thanks for the advice; the patient having, ſince the uſe of the powder, been eaſed of the diſtinct pain he was put to by the ulcers; and this relief laſted, if I miſremember not, above a year, and how much longer I know not. But I ſhall not inſiſt either upon this, or upon the teſtimonies and relations of *Paracelſus*, *Helmont*, *Goclenius*, *Burgravius*, nor even the modern Roman doctor, *Servius*, nor any of the other authors, that do profeſſedly take upon them the defence of the weapon-ſalve, by reaſon of what we have elſewhere to write to you, by way of examination of that ſalve, and the ſympathetick powder, that did incline me to think, that ſometimes it might work upon cures. But I ſhall alledge ſomething of more unexpected credit; and firſt *Dominicus Panarola*, now profeſſor of phyſick at *Rome*, in his newly divulged *Faſciculus Arcanorum*, preſents us two inſtances to our preſent purpoſe, in theſe words: *Mira* (ſays he) *quctidie reperiuntur in medicina ad confirmationem operis, quod doctiſſimus phyſicus, Petrus Servius* (the ſame we lately mentioned) *complevit de unguento armario, ſciendum eſt quod pecia ſanguine imbuta ſub cineribus calidis poſita menſes ſiſtit, experimento pluries comprobato: quinetiam magiſter meus Petrus Caſtellus* (whoſe name his late *Anatomy of the Civet Cat*, and other writings have made famous) *aiebat ſe expertum fuiſſe hæmorrhoides, ſi tangantur tuberoſa radice chondrilla ſiccari, ſi chondrilla ſiccetur; corrumpi verò ſi corrumpatur: quapropter ſub camino exſiccanda ponitur poſt hujuſmodi tactum chrondrilla tuberoſa.* ‘Wonderful things are daily found out in phyſick to the confirmation of the operation of the learned naturaliſt *Petrus Servius*'s weapon-ſalve. For he aſſured us, that a piece of cloth dipt in the blood, and put under hot aſhes, ſtops the monthly flux; the experiment having been often proved. And my maſter *Petrus Caſtellus* affirms, as he found by experience, that the hæmorrhoids, if they were touched with the tuberous root chondrilla, did dry away, if the chondrilla dried, and did run to corruption, if the chondrilla was corrupted. And therefore, after ſuch touching of hæmorrhoids, the chondrilla was uſually put to dry in the chimney.’ The learned *Salmuth*, in his obſervations, furniſhes us with an example of a moſt violent pain in the arm, removed by tranſplantation: they did beat up red corals with oaken leaves, and having kept them on the part affected 'till ſuppuration, they did in the morning put this mixture into an hole bored with an augur in the root of an oak, reſpecting the eaſt, and ſtop up this hole with a peg, made of the ſame tree: from thenceforth the pain did altogether ceaſe; and when they took out the amulet, immediately the torments returned ſharper than before. A great and excellent

The effects of weapon-ſalve, and other magnetical remedies.

Pamarola Faſc. arcan. 1.

Centur. 3. obſervat. 34.

excellent lady (a near kinſwoman, *Pyrophilus*, of yours and mine) and very far from credulous, confeſſed to me, as did her ſervants alſo, that with the above-mentioned remedy of aſhes and urine, ſhe was not only once cured of the yellow jaundice, by a friend of hers, that had obſerved, that ſhe had been fruitleſly vexed by a tedious courſe of phyſick, preſcribed by the famouſeſt doctor, then in *England*, but that afterwards relapſing into that ſame diſeaſe, ſhe had cured herſelf by the ſame remedy. I remember, that being ſome years ſince brought almoſt to the brink of the grave, by a ſudden effuſion of blood within my body, from which, without a ſignal mercy of God, I ſhould not have recovered; among other men ſkilled in phyſick that came to aſſiſt me in that danger, I was viſited by a Galeniſt of much repute, whoſe pale looks inviting me to inquire, what it was that ailed him, he anſwered me, That he had not long before been deſperately ſick of an obſtinate maraſmus, which, notwithſtanding all the remedies he could uſe, did daily ſo conſume him, that he appeared but a ſkeleton; whereupon having found the uneffectualneſs of ordinary remedies, and being hopeleſs of being relieved by them, he reſolved to try a ſympathetick medicine, which I remember my ſelf to have met with in *Hartman*. He took then an egg, and having boiled it hard in his own warm urine, he with a bodkin perforated the ſhell in many places, and then buried it in an ant-hill, where it was left to be devoured by the emmets; and as they waſted the egg, he found his diſtemper to leſſen, and his ſtrength to increaſe, inſomuch that he now conceived his diſeaſe to have quite left him.

Obſervations of the tranſplantation of diſeaſes. Riverius cent. 4. obſerv. 63.

Riverius cent. 4. obſerv. 19.

THE experienced *Riverius* in his laſt obſervations (newly publiſhed ſince his death) has two notable examples to our preſent purpoſe. For firſt he tells us, that the eldeſt daughter of a great officer in *France* was ſo tormented with a paronychia for four days together, that the pain made her paſs the night ſleepleſs: whereupon having, by *Riverius*'s order, put her finger into a cat's ear, within two hours ſhe was delivered from her pain, and her whole hand, which before was tumid, unſwelled again, except the finger, which it ſelf was out of pain. The other caſe was of a counſellor's wife, who by the ſame remedy was cured of a panaritium (which had for four days vext her) in a much ſhorter time than the other; namely, within a quarter of an hour. But that which chiefly makes theſe ſtories pertinent to our preſent occaſion, is this notable circumſtance, that in both the caſes, the cat was ſo manifeſtly put to pain, that *Riverius* thought it had attracted to itſelf the morbifick matter, from which it freed the patient. For in the former of theſe two caſes, the cat loudly complained of the pain he felt; and the other was, in that ſhort time the cure was performing, put to ſo much pain in his ear, that two men were hardly able to hold him faſt, he ſtruggled ſo forcibly. And theſe two relations of *Riverius* may, though there be ſome diſparity in the caſes, give ſome countenance to what might otherwiſe be diſtruſted in the obſervations of the induſtrious *Petrus Borellus*; where he ſays, *Podagra mirè levatur, ſi catelli cum podagrico recumbant, morbum enim contrahunt, adeò ut vix incedere queant*; *æger verò levamen ſuſcipit.* 'The gout is ſtrangely eaſed, if puppies lie with the perſon, that 'hath the gout; for they contract the diſeaſe ſo as not to be able to go, but the 'patient thereby finds eaſe.' Which perhaps he may have been induced to write, by the ſtory that goes of that odd chymiſt, *Robert Fludd*'s having tranſplanted the gout of one of his patients, by making him often ſleep with a dog, that was fond of him, who thereby became ſubject to ſuch periodical fits of the gout, as the maſter had been troubled with.

In hiſtoriar. & obſerv. 3. medico-phyſic. cent. 3. obſerv. 28.

[AND ſince I begun this chapter, and met with theſe objections, diſcourſing of this matter with a judicious perſon, well ſkilled in phyſick, and whom his learned writings have made eminent, he told me, that he had, not very many months ſince, ſeen a cure by tranſplantation, performed on the ſon of one, that was wont to make chymical veſſels for me. And becauſe the obſervation is conſiderable, that there might be no miſtake in it, he has pleaſed to ſet it me down in writing (atteſted with his annexed name) which enables me to preſent it to you in his own words: *N. N.* of *N.* potter, had a ſon, who was long ſick of the king's-evil, which ſwelled much, and broke into ſores at laſt, which he could by no ordinary means heal. The old man had then a dog, which took an uſe of licking the ſores; which the dog continued ſo long, till he waſted the very kernels of ulcers, that were knit in with the veins, and perfectly cured the ſore, but had the ſwelling tranſplanted to himſelf, ſo that he had thereupon a great ſwelling, that aroſe and continued on his throat. The lad was thereby freed, ſo continued to be till 1660, and for aught I know is ſo this day. This I ſaw, being there at that time to view the clays, and beſpeak retorts of the old man.*]

AND to confirm the credibility, as well as increaſe the number of our magnetical ways of cure; I ſhall add, that Sir *Francis Bacon* himſelf records, with great ſolemnity, his own having been freed, not only from very many new warts, but from one almoſt as old as he, by a piece of lard with the ſkin on it, which after having rubbed upon them, was expoſed out of a ſouthern window to putrefy. And therefore though the vanity and ſuperſtition of the authors, that ſpeak of magnetick remedies, and the impertinent circumſtances, that are uſually preſcribed, as neceſſary to their effectualneſs, do generally and juſtly enough make ſober men deſpiſe, or at leaſt ſuſpect ſuch unlikely ways of cure; yet in conſideration of inſtances lately produced (to which we may perhaps elſewhere add ſome others) and becauſe divers men, as well phyſicians as others, have ſeriouſly aſſured me of their having been ſome of them eye-witneſſes, and others, performers of ſuch cures; I am apt to think it fit, that a ſevere indeed, but yet further trial be made of phyſical experiments of this kind. And I cannot but commend the curioſity of Dr. *Harvey*, who, as rigid a naturaliſt as he is, ſcrupled not often to try the experiment mentioned by *Helmont*, of curing ſome tumours or excreſcencies, by holding on them for a pretty while (that the cold might throughly penetrate) the hand of a man dead of a lingring diſeaſe; which experiment the doctor was not long ſince pleaſed to tell me, he had ſometimes tried fruitleſly, but often with good ſucceſs. Nor doth the grand objection againſt ſuch experiments, namely, that ſuch or ſuch a perſon, having once made trial of them, found them not ſucceed, ſeem at all to me, alone, of weight enough to make ſuch experiments, or thoſe other improbable ones formerly mentioned, totally rejected. Becauſe, if they really do ſometimes ſucceed, though ſometimes they chance to fail, yet that poſſibility of their ſucceeding may ſufficiently evince, that there are really in nature medicines, that work after that extraordinary manner. And I ſee no reaſon, why it ſhould be more required of thoſe medicines, that work at diſtance from the patient, (or at leaſt are not taken at mouth, or injected otherwhere) only by ſubtile effluvia, that they ſhould always cure,

Cent. X. exp. 997.

The ſometimes not ſucceeding of magnetical medicines no ſufficient cauſe to abandon their uſe.

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* Some years ſince the preſent eſſay was written, I lighted on the 66th obſervation of the induſtrious *Bartholinus*, 3d cent. and the 53d obſervat. of his 6th century; in both which places giving inſtances of the tranſplantation of diſeaſes, he mentions, beſides ſome of thoſe examples delivered by us, divers others; for which I am willing to refer you to the alledged places: only in the laſt of theſe obſervations delivering ſomething as upon his own knowledge, (which he does not in the reſt of the inſtances) that much confirms what we have mentioned concerning *Fludd*. We ſhall annex it in his own words: *In catello Mileſio avi noſtri materni, quem jam alit in ædibus ſuis avunculus meus ſuſpiciendus M. Jacobus Finckius Phyſ. P. P. & academiæ noſtræ ſenior, evidentius hæc patuit trahendi facultas. Colico dolore torquebatur avunculus, canis ventri impoſitus, quum incaluiſſet, argebat exitum, vomuit vehementer, & tormina colica avunculi remiſerunt. Ancilla ejuſdem in dolore dentium eundem canem genis appoſuit, ſenſitque levamen, ſed canis dolorum mipatientia hinc inde curſitare & latrare. Idem expertus eſt ſcriba in colli tumore.*

than it is exacted of vulgar remedies, from which we might reaſonably expect more conſtant effects, becauſe of their being either inwardly given, or more immediately, or at leaſt, more durably applied to the patient. And if rhubarb be juſtly affirmed to be an excellent medicine in looſeneſſes, though we daily in *Ireland* ſee many ſwept away of thoſe diſeaſes, in ſpight of the uſe of rhubarb and mirabolans, with other aſtringent remedies to boot: and if quickſilver be, not unreaſonably, by moſt of our phyſicians, eſteemed and employed as an effectual remedy againſt venereal diſeaſes, becauſe it ſometimes removes them, through *Fernelius*, *Montanus*, and many other learned authors tells us, as they ſay upon their own experience, that (though it often palliate thoſe diſtempers) it very ſeldom cures them: nay, and if diaphoreticks are ſtill eſteemed ſuch by the generality of phyſicians, though few ſudorificks will cauſe ſweat in all bodies, and ſcarce any in ſome bodies; I ſee not, why theſe remedies, that work, as it were, by emanation, may not deſerve the name of medicines, if they ſometimes unqueſtionably ſucceed, though they ſhould not always prove ſucceſsful ones; nor why they ſhould, notwithſtanding their ſometimes not ſucceeding, be laid aſide; eſpecially ſince theſe ſympathetical ways of cure are moſt of them ſo ſafe and innocent, that though, if they be real, they may do much good, if they prove fictions they can do no harm; unleſs by accident, as in caſe the patient ſhould ſo ſingly rely on them, as to neglect (which he need not all) other helps to recover.

## CHAP. XII.

Inſtances of divers cures upon brutes, and how theſe are applicable to men.

BUT you will now perhaps demand, *Pyrophilus*, how the naturaliſt, as ſuch, can contribute to the credit or advancement of the mentioned ways of curing diſeaſes, without the wonted weakning and painful evacuations? In anſwer to this queſtion, I muſt put you in mind, that it would be no new thing for naturaliſts, not profeſſedly phyſicians, to treat of this ſubject; and that the naturaliſt may afford good hints to the practitioner of phyſick, both upon divers other accounts already touched upon, and by trying upon brutes variety of hitherto untried medicaments or remedies, and by ſuggeſting to him both the events of ſuch trials, and alſo what hath been already obſerved about the cures of diſeaſes incident to beaſts. For though (as we formerly told you) there are ſome things, that are not equally poiſonous, as others not equally ſafe, to man, and to ſome brutes; yet there are other beaſts, eſpecially dogs, and monkeys, whoſe bodies are, by many poiſons, affected almoſt like thoſe of men. And ſince, according to the rule, *Periculum faciendum eſt in vili anima*, many things may be very well tried on ſuch creatures, that we dare not at firſt venture to try on men; we may give dogs poiſons, only to try the virtue of our antidotes; and we may give them wounds, to make trial of the efficacy of the weapon-ſalve and ſympathetick powder: ſince divers of my friends (as I have intimated above) aſſure me, that they have ſome of them ſeen, and others performed cures of horſes, lamed by pricking, by ſticking the nails, that hurt them, into weapon ſalve; which, for that very uſe, among others, ſome of them are wont to carry about them in ſilver-boxes. When oxen and ſuch like cattle are troubled with that diſeaſe, which makes them continually turn about in one place, (and is therefore called the turning-evil, or ſturdy) a common remedy here in *England*, as graziers that make uſe of it inform me, is to caſt down and tie faſt the ſick beaſt, and then to open his ſkull a good way, (or, if need be, take off a round piece of it over the place ſuppoſed to be affected) and at the open place to take out a little bag or bladder, which is uſually found to lie near the membranes of the brain, and to be full of water and blood, and then leiſurely to heal up the hurt. And this cure is much commended, as both common and eaſy, by our experienced *Markham*. In goats likewiſe, that are much ſubject to the dropſy, the huſband-man ventures to ſlit, and let out the water under the ſhoulder. And divers hazardous operations in ſurgery, ſuch as are arteriotomy, the exſection of the ſpleen, and other parts, were, or ſhould have been firſt attempted upon brutes, and then practiſed on human bodies. And in imitation of theſe, it is likely, that divers other experiments, of good uſe in ſurgery, may be diſcovered for the relief of man, without endangering him in proſecuting ſuch diſcoveries. And to ſay nothing of the known practice of ſpaying ſwine, and bitches; in the neighbourhood of a country-houſe of mine, in the weſt of *England*, and probably in divers other parts, ſome experienced ſhepherds have an odd way of caſtrating male ſheep, eſpecially lambs, when they are grown ſo old, that it is thought dangerous to geld them the common way. A ſervant of mine, that deals much in cattle, and had lately divers ſheep ſwigged (as they call it) after this manner, tells me, that it is thus done: the beaſt, on whom the operation is to be performed, being held by a ſtrong man with his belly upwards, another man draws a ſtring, as firmly as he can (tying it with a knot or two, to prevent its yielding or ſlipping off) about the teſticles, as if he meant, by drawing that ſtring, to cut them off; and then anointing the part with a little freſh butter, or ſome ſuch like thing, he lets the ram go to feed; which, for the moſt part (notwithſtanding the anguiſh of this ligature) he will begin to do in a ſhort time: and within two or three days, the teſticles, being by the ſtrict ligature denied the nutriment and ſpirits, that were wont to be conveyed to them, will grow ſo rotten, as either, together with the ſtring, to fall off, or be very eaſily pulled off, ſometimes ſtinking very rankly like carrion. And even among thoſe things, that are already practiſed by farriers, ſhepherds, and graziers, there are many ſuch things, as we have newly mentioned, which may ſerve either to inrich or illuſtrate the way of curing human bodies: their ignorance and creduloуſneſs, together with the liberty and meanneſs of thoſe creatures they phyſick, give them leave to venture on any thing, having made them try upon horſes, and cattle, many ſuch things, as phyſicians dare not try upon men and women. And among thoſe many extravagant things, ſome, as it often happens, have ſucceeded ſo proſperouſly, as to deſerve to be conſidered by the ſkilfulleſt phyſicians; ſome of whom might, without diſparagement to their profeſſion, do it an uſeful piece of ſervice, if they would be pleaſed to collect and digeſt all the approved experiments and practices of the farriers, graziers, butchers, and the like, which the ancients did not deſpiſe, but honoured with the titles of *Hippiatrica*, and *Veterinaria*; and among which, if I had leiſure, divers things may be taken notice of, which might ſerve to illuſtrate the *methodus medendi*. As to give you but one inſtance, which lately occurred to me, the uſefulneſs of letting blood in ſome caſes, which is ſo ſeverely condemned by many chymiſts, and the efficacy of a ſmall, if ſeaſonable, evacuation, which can ſcarce be conceived to do more than alter the courſe of the blood, may be illuſtrated by the ſtaggers in horſes, and the cure of it. For I have ſeen a coach-horſe, ready to drop down dead of his diſeaſe upon the high-way, by having his gums rubbed with the coach-whip, till the blood appeared, relieved almoſt in a moment ſo much, that though he were not well able to ſtand before, yet he was immediately able to go on, and draw the coach with his fellows.

## CHAP. XIII.

THE next thing we are to obſerve to you, *Pyrcphilus*, and on which its nature and importance will ingage us ſomewhat long to inſiſt, is this; that the handling of phyſical matters was anciently thought to belong to the naturaliſt; as we are clearly informed by the judicious *Celſus*, in that memorable paſſage, where he ſpeaking of the origin of phyſick, *Primo* (ſays he) *medendi ſcientia ſapientiæ pars habebatur*; *ut morborum curatio & rerum naturæ contemplatio ſub iiſdem authoribus nata ſit: ſcilicet his hanc maxime requirentibus,*

That the handling of phyſical matters was anciently thought to belong to the naturaliſt. Celſus in præf. c. 1.

*requirentibus, qui corporum ſuorum robora, inquieta cogitatione nocturnaque vigiliâ minuerant.* ‘ At the firſt, phyſick was accounted part of philoſophy, ſo that the cure of diſeaſes, ‘ and the contemplation of nature, did both ariſe under the ſame authors; thoſe being ‘ moſt ſet upon medical inquiries, which had made their bodies infirm by diſquieting ‘ thoughtfulneſs, and nocturnal watchings.’ He adds, that many of the profeſſors of philoſophy, eſpecially *Pythagoras*, *Empedocles*, and *Democritus*, and that *Hippocrates* (whom ſome think to be the diſciple of the laſt named) was the firſt, that ſevered phyſick from philoſophy, and made it a diſtinct diſcipline. And this apology for the enſuing diſcourſe being thus premiſed to it, I ſhall further anſwer, that I ſhould perhaps be obliged to exceed the limits of an eſſay, if I ſhould in this diſcourſe inſiſt on every thing, upon whoſe account the naturaliſt may aſſiſt the phyſician, if he be barely a *medicus* to cure diſeaſes, which that you may the more readily believe, I ſhall ſelect and proſecute ſome of theſe things in the remaining part of this eſſay.

That the rejecting ſpecificks, becauſe they make no viſible evacuation, is irrational:

AND firſt I ſhall repreſent to you on this ſubject, that the account, upon which phyſicians are wont to reject, if not deride, the uſe of ſuch ſpecificks, as ſeem to work after a ſecret and unknown manner, and not by viſibly evacuating peccant humours (or by other ſuppoſedly manifeſt qualities) being generally this; that they ſee not, how the promiſed effects can well be produced by bodies, that muſt work after ſo peculiar and undiſcerned a manner; this being, I ſay, the great thing, that hinders phyſicians from endeavouring to find, or ſo much as being willing to make uſe of remedies of this ſort, the naturaliſts may do much towards the removal of this impediment, by ſhewing out of ſuch things, as may be met with or performed within the macrocoſm, that ſuch, or at leaſt as ſtrange operations, as are aſcribed to theſe ſpecificks, are not without example in nature; and conſequently ought not to be rejected, barely as being impoſſible. And indeed the phyſiology, wherewith phyſicians as well as others are wont to be imbued in the ſchools, has done many of them no ſmall diſſervice, by accuſtoming them to groſs apprehenſions of nature's ways of working. Whence it comes to paſs, that not a few even learned doctors will never expect, that any great matter ſhould be performed in diſeaſes, by ſuch remedies, as are neither obvious to the ſenſe, nor evacuate any groſs, or at leaſt ſenſible matter. Whereas, very great alterations may be wrought in a body, eſpecially if liquid, as is the blood and peccant humour, without the ingreſs or egreſs of any viſible matter, by the inteſtine commotion of the parts of the ſame body acting upon another, and thereby acquiring a differing motion, location, (if I may ſo ſpeak) or figure, which, with the other qualities and effects reſulting thence, may alter the motion and texture of the liquor, and thereby produce great changes in the body that harbours it. How much an unperceived receſs of a few ſubtile parts of a liquor may alter the nature of it, may be gueſſed at, by the obvious change of wine into vinegar; wherein upon the avolation (or perhaps but the miſplacing) of ſo little of the ſpirituous and ſulphureous part, that its preſence, abſence, or new combination with the other parts is not diſcernable to the eye, the ſcarce decreaſed liquor becomes of a quite differing nature from what it was. And though in *England* this degeneration be not wont to be ſo ſuddenly performed, by reaſon of the coldneſs of the climate, yet in hotter countries the change is much more ſpeedily made. As in *Braſil*, the above mentioned *Piſo* informs us, that the expreſſed juice of the ſugar-canes, which by coction, and farther ordering, would be certainly brought to ſugar, will of it ſelf keep ſweet but about four and twenty hours, and then begin to ſour, and be altogether unfit to make ſugar of, though very fit to turn into good vinegar. And this I find confirmed by a modern and applauded French writer, in his deſcription of ſome parts of the *Weſt-Indies*, inhabited by his nation: and relations of the ſame ſort, concerning the haſty ſouring of ſome other liquors in *America*, I have

That great changes may be made by only miſplacing, without any evacuation of the parts.

Lib. 4. cap. 10.

The making of vinegar is an inſtance of this truth, eſpecially in the Indies.

had from our Engliſh travellers and planters. And in the *Eaſt-Indies*, *Linſchoten* tells us of a change much more ſudden: for ſpeaking of the formerly mentioned *Sura*, or liquor, afforded by the wounded coco tree; ‘The ſame water (ſays he) ſtanding but ‘one hour in the ſun is very good vinegar, and in *India* they have none other.’ And that even very hurtful liquors (and why not then ſome peccant matter in the body?) may after the like manner change their nature, may appear by what we have formerly mentioned, and is unanimouſly affirmed by credible writers of ſeveral nations, concerning the juice of mandioca, which, being poiſon, when it is firſt expreſſed, does in a few hours, by fermentation, purge it ſelf, and loſe its pernicious nature. That alſo by the bare ingreſs of ſome ſubtile and not viſible matter, ſuch inteſtine commotions may be excited in liquors, may appear by the ſouring, which has been often obſerved upon great thunders to happen, not only to wines, but to other vinous liquors alſo; as I lately received from a great maſter of variety of liquors a complaint, that by ſome thunder, which happened here a few weeks ſince, almoſt all the beer and ale in the neighbourhood was ſpoiled. And I remember, that when I returned out of *Italy* through *Geneva*, there happened in that place an earthquake; upon which, the citizens complained, that much of their wine was ſoured, though I, that lodged in the higheſt part of the town, ſaw nothing to make me believe, that the bare ſucceſſion of the earth was capable to produce ſo great and ſudden an alteration in the wine.

chap. 56.

See Piſo, l. 1.

In the effects of thunder and earthquakes.

THAT ſuch inviſible corpuſcles may paſs from amulets, or other external remedies, into the blood and humours, and there produce great changes, will ſcarce ſeem improbable to him, that conſiders, how perſpirable, according to *Hippocrates*, a living body is; and that vegetable and animal bodies, whoſe texture is more looſe and open, may well be ſuppoſed to ſend forth expirations, ſince even divers minerals are found to do the like; as may appear by the odorable ſteams of rubbed brimſtone, and amber, by the corpuſcles, which perform the magnetick operations, by the emetick quality imparted to liquors by the glaſs of antimony, and by *crocus metallorum* barely infuſed in them, without ſenſibly loſing any thing, either of their bulk or weight; and by the virtue of killing worms, wherewith wine, and even water has been, not only by *Helmont*, but by divers other phyſicians, obſerved to be enriched, after a quantity of quick-ſilver has been for ſome hours ſhaken in it, though without any ſenſible deperdition of the ſubſtance of the mercury. And indeed I have ſomewhat wondered, that many learned modern phyſicians, either out of an affected ſeverity, or perhaps animoſity againſt chymiſts, overlook, or even deride, all operations of this nature; ſince I remember *Galen* himſelf not only confirms the like doctrine, by his reaſons and authority, but delivers a very ſtrange example of it; for, under the title of *Glychyſida*, treating of peony, he thus diſcourſes: *Eſt præterea omnino reſiccatoria; Eapropter haud deſperaverim eam ex collo pueris ſuſpenſam merito comitialem morbum ſanare. Equidem vidi puellum quandoque octo totis menſibus morbo comitiali liberum, ac poſtea fortuna cum quod à collo ſuſpenſum erat decidiſſet, protinus denuo convulſione correptum, rurſuſque ſuſpenſo in locum illius alio, inculpatè poſtea egiſſe. Porro viſum eſt mihi ſatius eſſe rurſum id collo detrahere, certioris experientiæ gratiâ: id cum feciſſem, ac puer iterum eſſet convulſus, magnam recentis radicis partem ex collo ejus ſuſpendimus, ac deinceps prorſum ſanus effectus eſt puer, nec poſtea convulſus eſt. Rationabile itaque erat, aut partes quaſpiam à radice defluentes, ac deinde per inſpirationem attractas, affectos ita locos curare, aut aërem à radice aſſiduè mutari & alterari. Nam hoc pacto ſuccus Cyrenaïcus collumellam phlegmone affectam juvat, & melanthion frictum palam catarrhos & coryzas deſiccat. Si quis id in calidum linteum rarum liget, aſſidueque calorem ex eo per inſpirationem in nares attrahat. Quin etiam ſi pluribus linis, & maximè marinæ purpuræ, collo viperæ injectis, illis viperam præfoces, eaque poſtea cujuſpiam collo obvincias, mirifice profueris tum pariſthmiis tum omnibus iis, quæ in collo*

Divers inſtances to prove, that inviſible corpuſcles may paſs from amulets, and cauſe great alterations in the juices of a man's body.

De Simp. Med. facultatibus, l. 6. Galen's example of peony-root, &c.

*expullulant:* ‘Beſides, it is altogether drying; and therefore I ſhould not deſpair, that it, being hung about childrens necks, might cure the falling-ſickneſs in them. I truly ſaw a lad, that ſometimes would be eight whole months free from the falling-ſickneſs, and then, when by chance this fell from off his neck, he became immediately ſurprized with a fit; and again, hanging another root in its place, he would continue well. Therefore, for experiment ſake, I thought good to take it again from his neck, which when I had done, and found, that the lad fell into his former convulſions, we took a great piece of a green root, and hung it about his neck, and from that time he continued well, and felt no more convulſions. It was therefore moſt probable, that either certain parts did exhale from the root, and were drawn into the body by inſpiration, which did ſo work upon the affected parts; or that the ambient air was continually changed and altered by the root: for after this manner the *ſuccus Cyrenaicus* cures the *phlegmone* upon the *uvula*; ſo catarrhs and other rheums are dried up by melanthium, if it be tyed up warm in fine linnen, and the hot fume of it be drawn up into the noſtrils by inſpiration. Nay, if you ſtrangle a viper with divers ſorts of threads, and eſpecially with the ſea-purple, and then you tye thoſe threads about the neck of your patient, you ſhall cure the ſwelling of the almonds of the ears, and all other ſwellings in the neck.’ Nay, that ſuch inviſible bodies, by paſſing through groſſer ones, and thereby changing the motion and nexus or juncture of their parts, may produce laſting alterations in the textures (though it be a paradox) ſeems not at all to me impoſſible. For we find the moſt fluid body of quickſilver has been ſometimes, (I ſay ſometimes) and therefore may, without ſenſible increaſe of bulk, be coagulated by a metalline exhalation, ſo as to be cut like lead, and to retain that ſolidity, till by ſome art or other it be reduced to its priſtine fluidneſs. You may be inclined to think, that the hard and ſolid body of iron has a permanent alteration made in its texture, if you hold a needle during a competent time near the pole of a vigorous loadſtone without touching it. For the magnetical effluvia (as may very probably be conceived) will ſo diſpoſe the parts of the neareſt extreme of the needle, as that they ſhall admit the ſteams, that come from one of the poles of the loadſtone, and not thoſe that come from the other: whereas by ſkilfully holding it to the contrary pole of the ſame ſtone, the internal pores, and conſequently the texture of the needle, will preſently be quite otherwiſe diſpoſed, in reference to the magnetical effluvia; as we more fully declare in another eſſay, where we ſhall, I ſuppoſe, alſo perſuade you, that the effects of the loadſtone are performed by ſubtle bodies iſſuing from, or paſſing through it. What we have in the former diſcourſe told you concerning our having at pleaſure changed the poles of a load-ſtone, by help of the magnetical effluvia of the earth, may let you ſee, that in ſtones alſo ſuch alterations are poſſible to be made. And in the next eſſay ſave one, we ſhall give you another inſtance pertinent to our purpoſe. For if you heat a ſlender piece of ſteel (as a graver, or the like) red hot, and ſuffer it to cool leiſurely in the air, it will continue flexible enough, and of ſo ſoft a texture, that you may eaſily make impreſſions on it with any hardned ſteel: but if, inſtead of cooling it thus ſlowly, you knock it into ſuch a dry body, as we ſhall there name to you, it will immediately grow ſo hard, as to be brittle. Which alteration, whether it be reſolved to proceed from the particular effluvia of the body, into which it is knocked, or barely from the ingreſs of the corpuſcles of cold, (if any ſuch there be) it will be however an inſtance not unfit for our purpoſe. And thoſe, *Pyrophilus*, that are converſant in glaſs-houſes, may eaſily obſerve, that glaſs acquires a more or leſs brittle texture, according as (to ſpeak in the glaſs men's language) it is baked. For if, after glaſſes are blown, they be quickly carried into the open air, they wont to be much more ſubject to break, than thoſe, that after they are faſhioned, are placed in a kind of very long oven, (which is wont to be built over the furnace, wherein the materials, whereof the glaſs is made, are kept in fuſion) and are by ſlow degrees refrigerated, and not till after ſome hours expoſed to the open air: for whether this difference of brittleneſs, and conſequently of texture, be aſcribed to the interrupted tranſcurſion of ſome etherial matter, through the pores of the glaſs, or to the inſinuations of the atoms of the cold; or to this, that the particles of the glaſs agitated by the heat were ſurprized by the cold, before they could make an end of thoſe motions, which were requiſite to their diſpoſing themſelves into the moſt durable texture; it is evident enough, that it is by no groſs or viſible body, that this permanent difference of texture is produced. Of the like to which we may elſewhere give you examples in ſome other concretes. That alſo in an human body great alterations may be made by very ſubtile effluvia, appears evidently, not only by the inſtances we have formerly given of the efficacy of ſome outwardly applied remedies, but by divers other things; as that many are purged by the bare odour of potions, of which I have been aſſured, upon his own obſervation, by the experienced town-phyſician of *Plimouth*, Dr. *D.* and of which *Salmuth*, in his Obſervations, gives us an inſtance in a young gentlewoman, whom he ſaw more happily purged by the odour of a potion, drank by her ſiſter, than ſhe was that took the medicine. And the ſame author tells us of one Dr. *Pfeil*, an eminent phyſician, who was wont, when he had a mind to be purged, to go into ſome apothecaries ſhop, where electuaries electively purging were preparing, to which having a while ſmelt, they would by their odour, after his return home, work with him ſix or ſeven times, as if he had ſwallowed the medicine it ſelf. And *Henricus ab Heer*, in the twenty ninth of his formerly commended Obſervations, tells us of a woman, that not only was wont to be copiouſly purged by drinking beef-broth, but having by a fall broken her leg, uſed no other cathartick, than the bare odour of that ſort of broth. And very obſervable to our purpoſe is the operation of the air, all along the ridge of the high mountain of *Peru*, called *Pariacaca*, of which the learned Jeſuit *Joſeph Acoſta* relates, that though he went as well prepared as he could, to withſtand the operations uſually produced in travels, by that piercing air; yet when he approached to the top of the mountain, he was (notwithſtanding all his proviſion) ſurprized with ſuch fits, and pangs of ſtriving and caſting, as he thought he ſhould caſt up his heart too; having, after meat, phlegm, and choler, both yellow and green, in the end with overſtriving caſt up blood; and continued thus ſick for three or four hours, till he had paſſed into a more temperate air than that of the top of the mountain; which runs about 500 leagues, and has every where, though not equally, this diſcompoſing property, having operated upon ſome of his companions, as well downwards as upwards. A greater proof of the power of the ſteams upon the body may be taken from the propagation of infectious diſeaſes, which being conveyed by inſenſible effluvia, from a ſick into a healthy body, are able to diſorder the whole œconomy of it, and act thoſe ſad tragedies, which phyſicians do ſo often unſucceſsfully endeavour to hinder. But you will ceaſe to doubt, that corpuſcles, though ſo ſmall as to be below the ſenſe, ſhould be able to perform great matters upon human bodies, if you conſider, what alterations may be therein produced by the bare actions of the parts upon one another. This may appear by the effects of ſeveral paſſions of the mind, which are often excited by the bare, if attentive, thoughts of abſent things. In obſtinate grief and melancholy, there is that alteration made in the diſpoſition of the heart, and perhaps ſome other parts, by which the blood is to circulate, that the lively motion of that liquor is thereby diſturbed, and obſtructions and other not eaſily removed diſtempers are occaſioned.

Of purging by the odour of potions.

Cent. 3. Obſerv. 4.

Cent. 3. Obſerv. 8.

Lib. 3. Cap. 9.

Of the purging and vomiting quality of the air of the mountain Pariacaca. 243, 244.

The power of ſteams ſeen in the infectious effluvia.

Of alterations made by the paſſions of the mind.

occaſioned. The bare remembrance of a loathſome potion does oftentimes produce in me (and I doubt not, but the like thought may have the like operation in many others) a horrour, attended with a very ſenſible commotion of divers parts of my body, eſpecially with a kind of convulſive motion, in or about the ſtomach. And what power the paſſions have to alter and determine the courſe of the blood, may appear yet more manifeſtly in modeſt and baſhful perſons, eſpecially women, when meerly upon the remembrance or thought of an unchaſte, or undecent thing, mentioned before them, the motion of the blood will be ſo determined, as to paſs ſuddenly and plentifully enough in the cheeks (and ſometimes other parts) to make them immediately wear that livery of virtue (as an old philoſopher ſtyled it) which we call a bluſh. And even by joy, if great and ſudden, I not long ſince ſaw in perſons of both ſexes, not only the cheeks and forehead, but it left (as to the lady) even the neck and ſhoulders dyed of that colour. And that paſſions may not only alter the motion of the juices of the body, but likewiſe make ſome ſeparation and evacuation of them, may appear in grief, which is wont, eſpecially in women, to make all the commotions requiſite to weeping; whereby oftentimes a conſiderable quantity of briny liquor is excluded at the eyes, under the form of tears, by which divers (eſpecially hyſterical) perſons are wont to find themſelves much refreſhed, though with ſome it fares otherwiſe in teeming women. Alſo that vehement deſire we call longing may well be ſuppoſed to produce great alterations in the body of the mother, which leaves ſuch ſtrange and laſting impreſſions upon that of the infant; ſince it is the mother only, and not at all the infant, that conceives thoſe importunate deſires.

## CHAP. XIV.

Divers inſtances of the power of imagination.

THERE are many inſtances to be met with in phyſicians books, to ſhew, that imagination is able ſo to alter the imagining perſon's body, as to work ſuch a diſpoſition in the ſpirits, blood and humours of it, as to produce the determinate diſeaſe that is exceſſively feared. And I remember, that ſoon after the laſt fair lady *R.* died of the ſmall-pox, I chanced to meet one of her ſiſters, with her maſk on, amongſt ſome other perſons of high quality, and wondering to ſee her ſit maſk'd in ſuch company, her huſband (who was preſent) told me, that his wife having been happily brought to bed ſome while before her ſiſter fell ſick, he had carefully kept the knowledge of her ſickneſs from his wife; leſt the kindneſs, that was betwixt them two, might prejudice her in the condition ſhe was in: but that after a while, a lady unawares making mention in her hearing of her ſiſter's ſickneſs, ſhe immediately fancied, that ſhe ſhould have it too, and accordingly fell ſick of that disfiguring diſeaſe, whoſe marks obliged her for a while to wear a maſk. Nor is it in women only, but even in men, that conceit may produce ſuch real and laſting effects. For many authentick hiſtories record examples of thoſe, in whom exceſſive grief or fear has made ſuch a change in the colour of their hair in a night, as nature would otherwiſe have ſcarce made in divers years. And I remember, that being about four or ſix years ſince, in the county of *Cork*, there was an Iriſh captain, a man of middle age and ſtature, who coming with ſome of his followers to render himſelf to your uncle *Broghill*, who then commanded the Engliſh forces in thoſe parts, upon a publick profer of pardon to the Iriſh, that would then lay down their arms, he was caſually, in a ſuſpicious place, met with by a party of the Engliſh, and intercepted. And my brother being then abſent upon a deſign, he was ſo apprehenſive of being put to death by the inferiour officers, before your uncle's return, that that anxiety of mind quickly changed the colour of his hair after a peculiar manner: of which I (being then at that caſtle of your uncle's, whereunto he was brought) had quickly notice

An inſtance of the hair of the head changed in colour upon a ſudden fear.

notice given me, and had the curioſity to examine this captain, and found, that the hair of his head, had not (as in the inſtances I had met with in hiſtories) uniformly changed its colour, but that here and there certain peculiar tufts and locks of it, whoſe baſes might be about an inch in diameter, were thus ſuddenly turned white all over: the reſt of his hair (of which you know the Iriſh uſe to wear good ſtore) retaining its former reddiſh colour.

[You will miſtake my deſign, *Pyrophilus*, if you conclude from what I have ſaid, concerning the power of effluvia to work upon the body, that I am either ſo much an Helmontian, as to condemn the uſe of all thoſe remedies, that make ſuch more groſs evacuations (if I may ſo call them) as are made by vomit, ſiege, and the like; or that I would have you, or am my ſelf ſo credulous, as to believe all the virtues, that are even by eminent writers aſcribed to the remedies called Specificks. For (to mention here but this) we have obſerved, that the hopes built upon even excellent ſpecificks, unleſs they be of ſuch a reſolving and abſterſive nature, as to be able to make way for themſelves into the receſſes of the body, are oftentimes diſappointed, where ſome emetick or cathartick remedy has not been firſt uſed to free the ſtomach and guts from thoſe viſcous humours, which obſtructing the firſt paſſages, much enervate the virtue of the remedy, if they do not altogether deny it acceſs to the innermoſt parts of the body. That then, which I aim at, is firſt to keep you from being prejudiced by the confidence of ſome learned doctors, who laugh at the very name of ſpecificks, and will not allow any diſeaſe to be curable, but by viſible evacuations of ſtore of what they call peccant matter; and next to give you cauſe to think, that ſuch ſpecificks, as men of judgment and credit do recommend upon their own experience, ought not to be rejected without trial, upon the bare account of their not being either laxative or vomitive, ſudorifick, or diuretical; nay, not ſo much as for this, that they are not endowed with any eminent degree of any manifeſt quality, ſuch as heat, cold, dryneſs, odour, taſte, aſtriction; and the like; nor able perchance to work any conſiderable alteration in a healthy human body. For I conſider the body of a living man, not as a rude heap of limbs and liquors, but as an engine conſiſting of ſeveral parts ſo ſet together, that there is a ſtrange and conſpiring communication betwixt them, by virtue whereof, a very weak and inconſiderable impreſſion of adventitious matter upon ſome one part may be able to work on ſome other diſtant part, or perhaps on the whole engine, a change far exceeding what the ſame adventitious body could do upon a body not ſo contrived. The faint motion of a man's little finger upon a ſmall piece of iron, that were no part of an engine, would produce no conſiderable effect; but when a muſket is ready to be ſhot off, then ſuch a motion being applied to the trigger by virtue of the contrivance of the engine, the ſpring is immediately let looſe, the cock falls down, and knocks the flint againſt the ſteel, opens the pan, ſtrikes fire upon the powder in it, which by the touch-hole fires the powder in the barrel, and that with great noiſe throws out the ponderous leaden-bullet, with violence enough to kill a man at ſeven or eight hundred foot diſtance. And that alſo the engine of an human body is ſo framed, as to be capable of receiving great alterations from ſeemingly ſlight impreſſions of outward objects, upon the bare account of its particular contrivance, may appear by ſeveral inſtances, beſide thoſe, which may belong to this argument in the foregoing part of this eſſay. When a man goes ſuddenly out into the ſun, it often happens, that thoſe beams, which light upon the head, and would not in ſo ſhort a time have any diſcernible effect on the leaſt hair of it, do almoſt in a moment produce that ſtrange and violent motion in the head, and almoſt all the body, which we call ſneezing. Men, that from the top of ſome pinnacle, or other high and ſteep place, do look down to the bottom of it, are at firſt very

How the author's diſcourſe concerning the power of effluvia ought to be underſtood.

That the particular ſtate and diſpoſition of the engine of an human body is conſiderable as to the effects of theſe impreſſions.

very apt, by the bare proſpect, (which yet conveys nothing into the body, but thoſe images, if yet there intervene corporeal ones in ſenſation of viſible objects, that enter the eye) to become ſo giddy, that they are reduced to turn away their eyes from the precipice, for fear of not being able to ſtand upon their legs. And many, that looked fixedly upon a whirlpool, or upon a very ſwift ſtream, have had ſuch a vertiginous motion thereby impreſſed on their ſpirits, that they have been unable to keep their bodies upright, but have fallen into the water they gazed on. And it is no leſs remarkable, that when a man is ſomewhat diſcompoſed at ſea, and yet not enough to vomit freely; the ſeamen are wont to adviſe him to look from the ſide of the ſhip upon the water, which ſeeming ſwiftly to paſs by the veſſel, has upon the gazer the operation of a rapid ſtream, and by making him giddy, haſtens and facilitates his vomiting; as I have ſometimes tried upon my ſelf, when I had a mind for health's ſake to be put into a fit of ſea-ſickneſs. If a perſon be very tickliſh, and you but gently ſtroke the ſole of his foot with the top of a feather, that languid impreſſion on the bottom of the foot ſhall, whether he will or no, put all thoſe muſcles and other parts into motion, which are requiſite to make that noiſe, and to exhibit that ſhape of the face (ſo far diſtant from the feet) which we call laughing; and ſo the gentle motion of a ſtraw, tickling the noſtrils, is able to excite ſneezing. Moſt men may obſerve in themſelves, that there are ſome ſuch noiſes, as thoſe made by the grating of an ungreaſed cart-wheel upon the axle-tree, or the tearing of coarſe paper, which are capable of ſetting the teeth on edge, which yet cannot be done without exciting a peculiar motion in ſeveral parts of the head. I had a ſervant, who ſometimes complained to me of a much more remarkable and unfrequent diſorder; namely, that when he was put to whet a knife, that ſtridulous motion of the air was wont to make his gums bleed. *Henricus ab Heer* (in his twenty ninth obſervation) records a ſtory of a lady, to whom he was ſent for, who upon the hearing of the ſound of a bell, or any loud noiſe, though ſinging, would fall into fits of ſounding, which was ſcarce diſtinguiſhable from death; and we may confirm, that this diſpoſition depended upon the texture of her body, in reference to material ſounds, by what he ſubjoins, that having well purged her, and giving her for two months the *Spaw*-waters, and other appropriate remedies, he thoroughly cured her. And it often enough happens, that when a woman is in a fit of the mother, another hyſterical perſon ſtanding by is, by reaſon of a peculiar diſpoſition of her body, ſoon infected with the like ſtrange diſcompoſure. And to ſhew you, that a diſtempered body is both an engine, and alſo an engine diſpoſed to receive alterations from ſuch impreſſions as will make none on a ſound body, let me put you in mind, that thoſe ſubtile ſteams, that wander through the air before conſiderable changes of weather diſcloſe themſelves, are wont to be painfully felt by many ſickly perſons, and more conſtantly by men, that have had great bruiſes or wounds, in the parts that have been ſo hurt; though neither are healthy men at all incommodated thereby, nor do thoſe themſelves, that have been hurt, feel any thing in thoſe ſound parts, whoſe tone or texture has not been altered or enfeebled by outward violence. I have known ſeveral alſo (and the thing is obvious) whoſe bodies and humours are ſo framed and conſtituted, that if (as men commonly ſpeak) they ride backward in a coach, that motion will make them giddy, and force them to vomit. And it is very ordinary for hyſterical women to fall into ſuch fits as counterfeit epilepſies, convulſions, and I know not what violent diſtempers, by the bare ſmell of muſk and amber, and other ſtrong perfumes, whoſe ſteams are yet ſo far from having great, much leſs ſuch effects in other human bodies, that almoſt all men, and the generality even of healthy women, are not affected by them, unleſs with ſome innocent delight. And that even on men, odours (how

In Pr. med. adm. l. 3. Obſervat. 99.

minute and inviſible bodies ſoever) may ſometimes have very great power, may be gathered from the ſtory told us by *Zacutus Luſitanus*, of a fiſherman, who having ſpent all his life at ſea, and being grown old there, and coming to gaze upon a ſolemn reception made in a maritime town, to *Sebaſtian* king of *Portugal*, was, by the perfumes plentifully burnt, to welcome the king, immediately caſt upon the ground thereby into a fit, which two phyſicians judged apoplectical, and phyſicked him accordingly, till three days after the king's chief phyſician, *Thomas à Vega*, gueſſing at the cauſe of the diſeaſe, commanded him to be removed to the ſea-ſide, and covered with ſea-weeds, where, within four hours, the maritime air and ſteams began to open his eyes, and made him know thoſe, that were about him, and within not many days reſtored him to health. We may alſo conjecture, how much the alteration produced in the body by ſickneſs may diſpoſe it to receive ſtrong impreſſions from things, that would not otherwiſe much affect it, by this; that even a man in perfect health, and who is wont to drink cold liquor without the leaſt harm, may, when he has much heated himſelf by exerciſe, be caſt by a draught of cold drink into ſuch ſudden, formidable and dangerous diſtempers, as, did not daily experience convince us, we ſhould ſcarce think poſſible to be produced in a body, free from morbid humours, by ſo familiar a thing as a cup of ſmall-beer or water: inſomuch that *Benivenius* relates a ſtory of one, who after too vehement exerciſe drinking a glaſs of very cold water fell into a ſwoon, that was quickly ſucceeded by death. And yet, to add that, on this occaſion, in bodies otherwiſe diſpoſed, a large draught of cold water, drunk even without thirſt, may very much relieve the drinker, and prevent great fits of the mother, and partly of the ſpleen, eſpecially upon ſudden frights; to which purpoſes, I know ſome hyſterical ladies, that find in this remedy, as themſelves aſſure me, more advantage, than one would eaſily imagine.

AND (farther) to ſhew you, that the engine we are ſpeaking of, is alterable, as well for the better as for the worſe, by ſuch motions of outward bodies, as, in themſelves conſidered, are languid, or at leaſt may ſeem deſpicable in reference to ſickneſs or recovery; let me call upon you to conſider a few, not unobvious, things, which may alſo ſerve to confirm ſome part of what has hitherto been delivered.

The effects of the moſs growing on a human ſkull in ſtanching blood.

[THE true moſs growing upon a human ſkull, though I do not find experience warrant all the ſtrange things ſome chymical writers attribute to it for the ſtanching of blood, yet I deny not, but in ſome bodies it does it wonderful enough. And I very well know an eminent virtuoſo, who has aſſured me, as his phyſician likewiſe has done, that he finds the effects of this moſs ſo conſiderable upon himſelf, that after having been let blood, his arm falling to bleed again, and he apprehending the conſequences of it, his phyſician who chanced to be preſent, put a little of the abovementioned moſs into his hand; which, barely held there did, to the patient's wonder, ſtanch his blood, and gave him the curioſity to lay it out of his hand, to try, whether the moſs were the cauſe of the blood's ſo oddly ſtopping its courſe; whereupon his arm, after a little while, beginning to bleed afreſh, he took the moſs again into his hand, and thereby preſently ſtanch'd his bleeding the ſecond time: and if I miſremember not he added, that he repeated the experiment once more with the like ſucceſs. The ſmoke of burnt feathers, or tobacco blown upon the face of an hyſterical woman, does oftentimes almoſt as ſuddenly recover them out of fits of the mother, as the odour of perfumes did caſt them thereinto.]

Burnt feathers, or the ſmoke of tobacco removes hyſterical fits.

Cures of dyſenteries by fumes.

AND now I ſpeak of cures performable by fumes, it brings into my mind, that a friend of yours and mine, and a perſon of great veracity, profeſſes to have ſtrangely cured dyſenteries by a way uſual enough; which is to make the patient ſit over a chair or ſtool cloſe on the ſides, and perforated below, ſo that the *anus* and the neighbouring parts may be expoſed to the fumes of ginger, which muſt be thrown upon a pan of embers, placed juſt under the patient, who is to continue in that poſture, and to receive the fume, as long as he can endure it without too much fainting. And when I mentioned one of the cures, that was thus performed, to one, that is looked upon as a maſter of chymical arcana againſt diſeaſes; he preferred before it (as he ſays upon experience) the ſhavings of hartſhorn uſed after the ſame manner; and the remedy ſeems not irrational. But if in this diſtemper, the actual heat applied to the above-mentioned part of the body concur not to the effect, we may too, warrantably enough, add, that cures may be performed by far more minute corpuſcles than thoſe of ſmoke, inſinuating themſelves from without into the body. For I know a very dexterous goldſmith, who, when he overheats himſelf, as he often unawares does at hammering of plate, is ſubject to fall into gripings of the belly, which lead to fluxes; but his uſual and ready cure is, as ſoon as conveniently he can, to heat his anvil, and ſit upon it for a great while together, heating it hot again, if there be need.

And by ſitting on a hot anvil.

Cures of the colick by glyſters of the ſmoke of tobacco.

But to return to our medicinal ſmokes, it is known, that ſome find more good againſt the fits of the colick, by the clyſters of the ſmoke of tobacco, than by any other phyſick they take; ſo that I know wealthy perſons, that relying upon the benefit they find by this remedy, have left off ſending for their phyſicians to eaſe them of the colick.

Of other cures done by ſmokes.

And indeed, when I conſider what an odd concrete even common ſoot is, and that many concretes, by being reſolved into ſmoke, may be either more or otherwiſe unlocked, than they would be by the ſtomach of a man, (ſo that I may elſewhere entertain you of the great heightening of ſome emetick and cathartick ſimples in their operation, by their being reduced into ſmoke) and that alſo probably the operation of ſome fumes and odours may be much changed and improved by their not getting into the body by the mouth, but other parts, I am inclinable to think, that there might be made further uſe of them, if phyſicians pleaſed, than hitherto has been. For I have made ſuch trial of the virtue of ſulphureous ſmoke, to preſerve ſome liquors, as I was much pleaſed with. And not only *Paracelſus*, but *Helmont* highly extols, as a grand ſpecifick in fits of the mother, the ſmoke of the warts, that grew upon the legs of horſes, conveyed to the parts ſuppoſed to be primarily affected. And I remember, that lately I met with a gentleman curious and intelligent, who, as himſelf aſſured me, was by the ſcurvy and ill-conditioned ulcers, and other obſtinate diſtempers, brought ſo low, that he was ſcarce able to turn himſelf freely in his bed, and thereupon reſolved againſt taking any more phyſick, partly out of deſpair of recovery, and partly of wearineſs of the tedious courſes of phyſick the doctors had in vain made him paſs through: but that ſome of his friends bringing him a certain ſurgeon, whom they affirmed to have ſtrangely cured many deſperate diſtempers, by ways very unuſual and not troubleſome to the patient, this gentleman was content to put himſelf into his hands; the ſurgeon promiſing, that he would not give him any other phyſick, but now and then a cup of ſack by way of cordial; his way of cure being to fumigate the patient very well every morning with a certain ſmoke, which that gentleman thinks, by what he took notice of, in the powder that yielded it, to have been ſome vegetable ſubſtance. And with this remedy in a ſhort time he grew perfectly well, and came home a while ſince in very good health, from a voyage, which the confuſions of his own country invited him to make as far as the *Eaſt-Indies*. This ſurgeon, whoſe name I cannot hit upon, dying ſuddenly, his ſecret (which was tried upon divers others beſides this gentleman) is, for aught we know, dead with him.

[BUT as for the efficacy, that may be found in appropriated fumes and ſteams, we have more than once, by barely unſtopping and holding under her noſe a ſmall phial of highly rectified ſpirit of ſal-armoniack, or even of hartſhorn, almoſt preſently recovered a young beauty, I need not name to you, out of ſtrange fits, that were wont to take her more ſuddenly than thoſe of the falling-ſickneſs, and were looked upon as epileptical, though perchance they were not merely ſo. To which I ſhall add, that a lady, that both you, *Pyrophilus*, and I know and love very well, though ſhe have been long ſubject to violent and tedious fits of the head-ach, and though that diſtemper hath been much increaſed by a great concuſſion of her head, occaſioned by the overturning of a coach, yet ſhe is wont preſently to be relieved, barely by holding her head a pretty while over a ſtrong decoction of tea, and breathing in the ſteams of it.]

Of the ſudden ceaſing of the plague at Grand Cairo in June.

AND now I am diſcourſing of cures made by ſteams, or other ſeemingly ſlight means, I muſt not pretermit a thing ſo remarkable, that if it were more generally known in *Europe*, I ſhall think it ſomewhat ſtrange to find it ſo little reflected on by phyſicians; and that is, the conſtant and almoſt ſudden ceaſing of the plague, how raging ſoever, in the almoſt incredibly populous city of *Grand Cairo* in *Egypt* towards the latter end of *June*, about which time in moſt countries in our hemiſphere it is wont to ſpread faſteſt, and be moſt rife. The truth of this is atteſted by ſo many travellers of ſeveral nations, that it were injurious to doubt of it; and not only the dexterous Mr. *R.* whom you well know, and who lived at *Cairo*, has confirmed to me the truth of it, but the learned *Proſper Alpinus*, who both was an excellent phyſician, and ſpent many years in *Egypt*, gives us this particular account of it: *Peſtis Cayri atque in omnibus locis Ægypti invadere eos populos ſolet ineunte Septembri menſe, uſque ad Junium: his enim omnibus menſibus, à Septembri ad Junium uſque, peſtis aliunde per contagium illuc aſportata eam gentem invadere ſolet.* And after a few lines, *Junio verò menſe, qualiſcunque & quantacunque ſit ibi peſtilentia, ſole primam cancri partem ingrediente, omnino tollitur, quod multis planè divinum eſſe non immeritò videtur: ſed quo etiam valde mirabile creditur, omnia ſupellectilia peſtifero contagio infecta tunc nullum contagii effectum in eam gentem edunt; ita ut tunc ea vobis in tutiſſimo & tranquilliſſimo ſtatu reducatur ex ſummè morboſo: atque morbi particulares, ſporadici à Græcis vocati, tunc apparere incipiunt, qui nuſquam gentium tempore peſtis apparebant.* ' The plague at ' *Grand Cairo*, and in all parts of *Ægypt*, is wont to invade the inhabitants from the ' beginning of the month *September* until *June*: for in all theſe months, from *September* unto *June*, the plague from other nations is brought thither, and is wont to ' infect that nation. But in the month of *June*, of what nature and how great ſoever ' the peſtilence be, when the ſun firſt enters *Cancer*, it is immediately removed; ' which thing many (and that not without reaſon) take to be a particular mercy of ' God. But (what is more admirable) all houſhold-ſtuff, however infected with the ' contagion of the diſeaſe, at that time ſhews no effect of any contagion, ſo that then ' the whole nation paſſes into a moſt ſecure and healthy condition, from a morbid and ' dangerous; and then thoſe diſeaſes, which are called by the Greeks *Sporadici*, begin ' to appear, which in no part of the world are ſeen to be rife together with the ' plague.' And in the next chapter, inquiring at large into the cauſes of this wonder, he denies it to proceed from the increaſe of the *Nile*, which happens to be coincident in point of time with the extinction of the plague, becauſe that the infection ceaſeth before the ſwelling of the river is conſiderable; and aſcribeth it rather to the alteration of the air, produced by the northerly winds, which then begin to blow, and ſome other circumſtances: ſpeaking of which, *Hæc* (ſaith he) *per id temporis incipiunt obſervari, à quibus fortaſſe non immeritò cauſam extinctionis peſtis morboſique in ſalubrem ſtatum mutationis pendere arbitror: quando nulla alia ex conſervatricibus cauſis, quas vulgus medicorum res non naturales appellat, aëre excepto, ibi eo*

De medicina Egyptiorum. Lib. 1. cap. 17.

Ibidem, c. 18.

*tempore appareat, in quam morboſi ſtatus in ſalubrem mutationem referre poſſumus: ideo neceſſarium erit hujuſce mutationis cauſam aëris mutationi acceptam referre, &c.* ‘ Theſe ‘ things are firſt obſerved about that time. From which, I think, and perchance ‘ not without reaſon, the cauſe of the extinction of the plague, and the change of the ‘ ſtate from morbid to wholeſome doth depend; for no other of the conſervative ‘ cauſes, which are wont to be called by phyſicians *res nonnaturales*, appeareth ‘ then, beſides the air: to which we may refer this change from diſeaſe to ‘ healthineſs; and therefore we muſt refer this change to the change of the air.’ Upon this inſtance, *Pyrophilus*, I have preſumed the longer to inſiſt, becauſe (if you duly reflect on it) you will, I ſuppoſe, diſcern, that it much credits and elucidates a great part of what hath been delivered in divers of the foregoing leaves, concerning the poſſibility of nature's doing great matters againſt diſeaſes, without the help of groſs and ſenſible evacuations.

## CHAP. XV.

AND ſince we have repreſented a human body as an engine, we ſhall add, that it may be altered both for the better and for the worſe, by ſuch bare motions or impulſes of external bodies, as act but in a groſs and confeſſedly mechanical manner. For it is known, that out of ſuch ſpeedily killing (unleſs ſeaſonably remedied) diſtempers, as fits of ſwooning, patients of either ſex are often recovered without any inward medicine, by being barely pinched in ſeveral places. I, that have endured great and dangerous ſickneſſes, have ſcarce ever found any ſo violent for the time, as that, which the bare motion and ſmell of a ſhip and ſea-air hath put me into, eſpecially in rough weather, till I was ſomewhat accuſtomed to navigation; and yet this violent and weakning ſickneſs, as it was not produced by a peccant humour in the body, ſo it was quickly removed by the air, and quiet of the ſhore, without the help of phyſick. And the like may be obſerved more ſuddenly in the newly mentioned inſtances of thoſe, in whom the bare agitation of a coach will produce ſuch violent fits of vomiting, and ſuch faintneſs, that I have known ſome of them apprehend they ſhould preſently die; ſo the bare ceſſation of that diſcompoſing motion ſoon relieved them. We ſee in our ſtables, what operation the currying of them carefully hath upon our horſes. And *Helmont* ſomewhere tells us, that himſelf, as I remember, could, by the milk of an aſs, tell whether ſhe had been that day diligently curried or no; and ſo conſiderable an alteration in milk ſhould methinks ſtrongly argue, that a great one is in the blood or other juice, of which the blood is elaborated, and conſequently in divers of the principal parts of the body muſt have preceded it. But to prefer our conſideration from the bodies of beaſts to thoſe of men, it is remarkable what *Piſo* confeſſeth, the illiterate Braſilian empiricks are able to perform with frictions, even as unſkilfully as they order them: *Mira equidem*, ſaith he, *tum tuendæ ſanitatis ergo, cum in pleriſque morbis ſanandis, frictione & unctione frequenti incolæ præſtant, illam frigidioribus, & chronicis, hanc in acutioribus adhibentes. Quæ remedia lubenter advenæ imitantur, &, ut par eſt, ex legibus artis hæc & plura medendi empiricorum genera moderantur.* ‘ The inhabitants do ſtrange things, both in ‘ preſerving health and in curing diſeaſes, by friction and unction, uſing the firſt in ‘ cold and chronical, the latter in acute diſeaſes. And ſtrangers, who arrive there, ‘ are, as they ought, willing to imitate their ways of phyſick, and by rules of art to ‘ preſide and moderate theſe ways of empirical healing.’ And as *Galen* himſelf highly extols a ſkilful application of cupping-glaſſes in the colick; ſo in *Braſil* they find, that the like remedy is ſtrangely ſucceſsful: for *Cholera ſicca*, ſaith our candid *Piſo* in another place, *eiſdem ferè remediis* (of which he had been ſpeaking) *curatur, maximè ſi*

That human body may be altered by ſuch motions, as act in a groſs and meerly mechanical manner, proved by divers inſtances.

Hiſtor. Nat. Med. lib. 2. cap. 5. p. 33.

Idem, cap. 11.

*regioni hepatis corneæ cucurbitulæ applicentur. De quibus merito hoc teſtor, quod Galenus de ſuis cucurbitulis, quas in colico affectu incantamenti inſtar operari tradidit.* ‘ *Cholera* ‘ *ſicca* is cured by the ſame remedies, eſpecially if their horny cupping-glaſs be applied ‘ to the region of the liver, of which I muſt atteſt the ſame thing, that *Galen* doth of ‘ cupping-glaſſes; which he affirmed to work as miraculouſly, as if their operation ‘ had depended on enchantment.’

We ſhall add, for further confirmation, that notwithſtanding all the horrid ſymptoms, that are wont to enſue upon the biting of that poiſonous ſpider, the *Tarantula*, that laſting and formidable diſeaſe, which often mocks all other remedies, is by nothing ſo ſucceſsfully oppoſed, as by muſick; ſome determinate tune or other, which proves ſuitable to the particular nature of the patient's body, or that of the poiſon, producing there ſuch a motion, or determination of ſome former motion of the ſpirits, or the humours, or both, as by conducting the ſpirits into the nerves and muſcles inſervient to the motion of the limbs, doth make the patient leap and dance, till he have put himſelf into a ſweat, that breathes out much of the virulent matter, which hath been probably fitted for expulſion, by ſome change wrought in its texture or motion, or thoſe of the blood, by the muſick. For if ſweat and exerciſe, as ſuch, were all that relieved him, why might not ſudoricks, or leaping without muſick, excuſe the need of fidlers? which yet is ſo great, that *Kircher* informs us, that the Apuleian magiſtrates are wont to give ſtipends, at their publick charge, to ſuch, to relieve the poor by their playing. And not only he hath the memorable ſtory of *Robertus Pantarus*, a Tarantine nobleman, whoſe diſeaſe being not known to proceed from the biting of a ſpider, could by no remedies be cured; he was at length, even upon the point of death, ſuddenly relieved, and by degrees reſtored to perfect health by the uſe of muſick: but *Epiphanius Ferdinandus*, in his accurate obſervations concerning thoſe bitten with the tarantula, together with *Mathiolus*, and other authors, bear witneſs thereunto by reſembling narratives. Now that a ſound (not barely as a ſound, ~~but~~ ſo modified) may powerfully operate upon the blood and ſpirits, I, who am very muſically given, have divers times obſerved in myſelf, upon the hearing of certain notes. And it might be made probable, both by that, which we have formerly ſaid of the effect of ſkreaking upon the teeth and gums, and by the dancing fit, into which not every muſical ſound, though never ſo loud, but ſome determinate tune is wont to put the bitten patient. But it may be more manifeſtly proved, by the following teſtimony of our inquiſitive Jeſuit, wherein he affirms, that the ſpiders may, as well as thoſe they have bitten, be made to dance by tunes ſuited to their peculiar conſtitutions.*

The inſtances of the cure of the Tarantula by muſick particularly modified.

Muſurg. lib. 9. cap. 4.

And this I the leſs wonder at, becauſe *Epiphanius Ferdinandus* himſelf not only tells us of a man of 94 years of age, and ſo weak, that he could not go, unleſs ſupported by his ſtaff, who did, upon the hearing of muſick after he was bitten, immediately fall a dancing and capering like a kid; and affirms, that Tarantulas themſelves may be brought to leap and dance at the ſound of lutes, ſmall drums, bag-pipes, fiddles, *&c.* but challenges thoſe, that believe them not, to come and try, promiſing them an ocular conviction: and adds, what is very memorable and pleaſant, that not only men, in whom much may be aſcribed to fancy, but other animals being bitten, may likewiſe, by muſick, be reduced to leap or dance: for he ſaith, he ſaw a waſp, which being bitten by a Tarantula whilſt a lutaniſt chanced to be by; the muſician playing on his inſtrument, gave them the ſport of ſeeing both the waſp and ſpider begin to dance: annexing, that a bitten cock did the like.

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* *Ubi ſonatores, qui muſica ſua hoc malum etiam publicis magiſtratus ſtipendiis ad pauperum remedium ſolatiumque conducti curare conſueverunt, ad curas patientium certius faciliuſque accelerandus; primo ex infectis quærere ſolent ubi, quo loco, aut campo, aut cujus coloris Tarantula erat, a quo morſus ipſis ſit inflictus. Quo facto indicatum locum protinus, ubi frequentes numero atque omnis generis Tarantulæ retium texendorum laboribus incumbunt, accedere ſolent medici citharædi, variaque tentare harmoniarum genera: ad quæ (mirum dictu) nunc has nunc illas ſaltare non ſecus ac duorum polychordorum æqualiter concinnatorum, perſonatione illæ chordæ, quæ ſimiles ſibi fuerint tono, & æqualiter tenſæ moventur, reliquis immotis, ita ut pro ſimilitudine & conditione Tarantularum, nunc has nunc illas ſaltare comperiunt. Cum verò ejus coloris Tarantulam, quæ à patiente indicata fuerit, in ſaltum prorumpere viderint, pro certiſſimo ſigno habent, modulum ſe habere verum & certum, humori veneno τȣ̃ ταραντιζοντος proportionatum, & ad curandum aptiſſimum, quo ſi utantur, infallibilem curæ effectum ſe conſequi aſſueverunt.* Kircher. Muſurg. lib. 9. part 2. cap. 4.

## CHAP. XVI.

Divers inſtances of the Ἰδιο-συγκρασίαι, or peculiar averſion of particular perſons from particular things, and of the commotions made in the body thereby.

I MIGHT alſo, *Pyrophilus*, confirm what I told you, when I ſaid, that ſickneſs may produce ſuch an alteration in the fabrick of the body, as to make it capable to be very much affected, as well for the better as for the worſe, by ſuch things, that would not ſcarce at all effect it if it were ſound, from the conſideration of thoſe many and ſtrange *ἰδιοσυνκρασίαι*, or peculiarities, to be met with in ſome perſons in ſickneſs and in health. For though many of theſe differences between healthy men are not likely to be greater, than may be obſerved between the ſame man, when well, and himſelf as the œconomy of his body may be diſcompoſed by ſome diſtemper; yet we often ſee, that ſome perſons have the engine of their body ſo framed, that it is wonderfully diſordered by ſuch things, as either work not at all on others, or work otherwiſe on them; as it is common enough for men to be hugely diſturbed, and ſome of them to fall into fits of trembling and ſwooning, upon the ſight or hearing of a cat. And to ſuch an affection I knew a very eminent commander obnoxious, your late uncle, the laſt Earl of *Barrymore*, a very gallant nobleman, and who did his country great ſervice in the Iriſh wars, had the like apprehenſion for tanſey. I cannot ſee a ſpider near me, without feeling a notable commotion in my blood, though I never received harm from that ſort of creature, and have no ſuch abhorring againſt vipers, toads, or other venomous animals. You know an excellent lady (married to a great perſon, that hath more than once governed *Ireland)* whoſe antipathy to honey, which is much talked of in that country, hath diſplayed it ſelf upon ſeveral occaſions; notwithſtanding which, her experienced phyſician imagining, that there might be ſomething of deceit in her averſion, took an opportunity to ſatiſfy himſelf, by mixing a little honey with other ingredients of a remedy which he applied to a very ſlight and inconſiderable cut or ſcratch, which ſhe chanced to get on her foot; but he ſoon repented of his curioſity, upon the ſtrange and unexpected diſorder, which ceaſing upon the removal of that, and application of other ordinary remedies, ſatisfied him, that thoſe ſymptoms were to be imputed to the honey, and not the bare hurt. The ſame excellent lady, I remember, complained to me, that when ſhe was troubled with coughs, all the vulgar pectoral and pulmonick remedies did her no good, ſo that ſhe could find relief in nothing but either the fume of powdred amber, taken with convenient herbs in a pipe, or that *Balſamum ſulphuris*, which we have already taught you in this eſſay.

[I know a perſon of quality, tall and ſtrong made, who lately aſked my opinion, whether, when he had need of a vomit, he ſhould continue to make uſe of coffee, in regard it wrought ſo violently with him: this gave me the occaſion, as well as curioſity, of inquiring particularly both of himſelf and his lady, concerning this odd operation of coffee upon him; and I was told, that an ordinary wine-glaſs full of the uſual warm decoction of coffee boiled in common water, was wont, within about two hours, to prove emetick with him, and before noon did give him eight, ten, or ſometimes

times twelve vomits, with ſo much violence, that he was leſs affected by the infuſion of *Crocus metallorum*, or other uſual emeticks, and therefore was deliberating, whether he ſhould not change coffee for ſome of them, though finding its operation very certain, he had for ſome years accuſtomed himſelf to take that vomit. And that, which is alſo remarkable in this matter, is, that he tells me, that ſcarce any vomit is more troubleſome to him to take, than that above mentioned is grown of late, ſo that even the odour of coffee, as he paſſeth by the coffee-houſes in the ſtreet, doth make him ſick; and yet that ſimple is to moſt men ſo far from being vomitive, that it is by eminent phyſicians, and in ſome caſes not without cauſe, much extolled as a ſtrengthener of the ſtomach. And this very gentleman himſelf uſed it a pretty while againſt the fumes, that offended his head, without finding any vomitive quality at all in it.]

THE books of ſober and learned phyſicians afford us examples of divers ſuch, and of much more ſtrange peculiarities, and likewiſe of ſuch perſons, who having deſires of certain things very extravagant, and even abſurd, (ordinarily not only improper, but hurtful to their diſtempers) have been cured by the uſe of them, of very dangerous and ſometimes hopeleſs diſeaſes: of which kind of cures I may alſo elſewhere tell you what I have obſerved, and ſome credit may be brought to ſuch relations, by what we ordinarily ſee more greedily devoured (without much harm) by longing women, and maids troubled with the green-ſickneſs.

That ſince the body receives ſuch alterations from ſuch unlikely things, there is no juſt arguing againſt ſpecificks, becauſe they operate not by any obvious qualities.

BUT now, *Pyrophilus*, ſince the engine of an human body thus appears to be ſo framed, that it is capable of receiving great alterations from ſuch unlikely things as thoſe we have been mentioning; why ſhould we haſtily conclude againſt the efficacy of ſpecificks, taken into the body, upon the bare account of their not operating by any obvious quality, if they be recommended unto us upon their own experience by ſober and faithful perſons? and that ſcarce ſenſible quantities of matter, having once obtained acceſs to the maſs of blood (which is very eaſily done by the circulation) may, by the contrary and ſwift motion, and by the figure of the corpuſcles it conſiſts of, give ſuch a new and unnatural impediment or determination to the motion of the blood, as to diſcompoſe either its texture, or that of the heart, brain, liver, ſpleen, or ſome ſuch principal part of the body, (as a ſpark of fire reduceth a whole barrel of gunpowder, to obey the laws of its motion, and become fire too; or as a little leaven is able, by degrees, to turn the greateſt lump of dow into leaven) need be manifeſted by nothing, but the operations of ſuch poiſons, as work not by any of thoſe (which phyſicians are pleaſed to call) *Manifeſt Qualities*. For though I much fear, that moſt of thoſe, that have written concerning poiſons, ſuppoſing that men would rather believe than try what they relate, have allowed themſelves to deliver many things more ſtrange than true; yet the known effects of a very ſmall quantity of opium, or of arſenick, of the ſcarce diſcernable hurt made by a viper's tooth, and eſpecially of the biting of a mad dog, (which ſometimes, by leſs of his ſpittle than would weigh half a grain, ſubdues a whole great ox into the like madneſs, and produceth truly-wonderful ſymptoms both in mens bodies and beaſts) are ſufficient to evince what we propoſed.

AND that man's body may be as well ſometimes cured, as we ſee it too often diſcompoſed, by ſuch little proportions of matter, may (not now to mention the queſtionable virtues aſcribed to many antidotes) be gathered from that experiment, ſo common in *Italy* and elſewhere, of curing the invenomed biting of ſcorpions, by anointing the bitten and tumid place with common oil, wherein ſtore of ſcorpions have been drowned and ſteeped. And a reſembling example of the antidotal virtue, wherewith nature hath enriched ſome bodies, is given us by the above commended

*Piſo*, in his *Medicina Braſilienſis*, where (treating of the antidotal efficacy of the famous Braſilian herb *Nhanby*, eaten upon an empty ſtomach) he adds this memorable ſtory; That he himſelf ſaw a Braſilian, who having caught an over-grown toad, and ſwelled with poiſon (ſuch a one as Braſilians call *Cururu*) which uſeth to be as big again as the European toad, and deſperately venomous (which perhaps our toads are not) he preſently killed him, by dropping on his back the juice of the flowers and leaves of that admirable plant. And you may remember, that the ſame author formerly told us, in effect, that as great and ſalutary changes may be produced even in human bodies, where he relates, that he had known thoſe, that had eaten ſeveral ſorts of poiſon, ſnatched in a trice from imminent death, by only drinking ſome of the infuſion of the root he calls *Jaborandi*; and this, after I know not how many alexipharmaca and theriacal antidotes had been fruitleſly adminiſtred.

You will perchance tell me, *Pyrophilus*, that theſe three or four laſt inſtances are of poiſonous diſtempers, and their antidotes; not of ordinary diſeaſes, and their ſpecifick remedies. But to this I have a double anſwer: and firſt, many of thoſe diſtempers, that proceed from poiſon, are really diſeaſes, and both called by that name, and treated of as ſuch, by phyſicians. And indeed they may well look upon them but as diſeaſes, exaſperated by a virulent malignity, which yet appears to be not always eaſily diſtinguiſhable from that of diſeaſes, that proceed not from poiſon, by this, that otherwiſe the phyſicians of princes and great men, if, after having conſidered all the inward parts of their diſ-bowelled patients, could not ſo often doubt and diſpute, as they do, whether or no poiſon were acceſſary to their death. And *Piſo* (who learnt divers of their deteſtable ſecrets from the Braſilians) relates, That ſome of them are ſo ſkilful in the curſed art of tempering and allaying their poiſons, that they will often hinder them from diſcloſing their deleterial nature for ſo long a time, that the ſubtile murderers do, as unſuſpectedly as fatally, execute their malice or revenge. Theſe diſeaſes indeed are wont to differ in this from ſurfeits, and other reſembling ordinary diſeaſes; that in the one, the venomous matter, that produceth the diſeaſe, is at firſt much more ſmall, than in the other the morbifick matter is wont to be. But the activity of this little quantity of hoſtile matter doth make it pernicious; that the diſorders it produceth in the body, being much greater than that of ordinary ſickneſſes is, the cure of ſuch diſtempers is the fitter to manifeſt how powerfully nature may be ſuccoured by remedies, that work not by firſt or ſecond qualities, ſince ſuch are able to deliver her from diſeaſes heightned by a peculiar and venomous malignity.

To this firſt I ſhall ſubjoin my next, which is, That divers paſſages of the former diſcourſe (eſpecially what we have related concerning the cures of agues, of the rickets, and of the king's evil) may ſatisfy you, that even of ordinary diſeaſes (ſome at leaſt) may be as well cured by ſpecificks, as thoſe produced by poiſon are by antidotes.

You may alſo ſay, *Pyrophilus*, 'But what if a recommended ſpecifick do not 'only ſeem unable to produce the promiſed effect, but have qualities, which ac'cording to our notions of the nature of the diſeaſe, ſeem likely to conſpire with it 'and increaſe it?'

I anſwer,

What is to be done, when the ſpecifick ſeems likely to increaſe the diſeaſe.

FIRST, That though it is better for the patient to be cured by a raſhly and unſkilfully given medicine, than to die under the uſe of the moſt ſkilfully adminiſtred phyſick; yet that the phyſician, who loſeth his patient, after having done all, that his art preſcribed to ſave him, deſerves more commendation than he, that luckily chanceth to cure his patient by an irrational courſe. And therefore in ſuch a caſe as you put, *Pyrophilus*, I think the phyſician ought to be very well ſatisfied, as to the matter of fact, before he venture to try ſuch a remedy; eſpecially if more ordinary and unſuſpected means have not been imployed and found ineffectual: for it is not one lucky cure, that ought to recommend to a wary phyſician the uſe of a remedy, whoſe dangerous quality ſeems obvious, where its virtue muſt be credited upon report.

But then, ſecondly, If the phyſician be duly ſatisfied of the efficacy of the remedy, upon a competent number and variety of patients, I ſuppoſe he may, without raſhneſs, make uſe of ſuch remedies, at leaſt where ordinary medicines have been already fruitleſly tried.

## CHAP. XVIII.

THAT you may ceaſe to wonder at my daring to ſay this, *Pyrophilus*, I muſt offer to you three or four particulars.

A diſquiſition concerning the ordinary method of phyſick.

And firſt, it is manifeſt to thoſe that are inquiſitive, that the true nature and cauſes of ſeveral diſeaſes are much leſs certain, and much more diſputed of amongſt the doctors themſelves, than thoſe that are not inquiſitive imagine: nor is the method of curing divers particular diſeaſes more ſettled and agreed on, that depending chiefly upon the knowledge of thoſe cauſes, which, as I was ſaying, are controverted. It is not, that I am either an enemy to method in phyſick, or an undervaluer of it; but I fear the generality of phyſicians (for I intend not, nor need all along this eſſay ſpeak of them all) have as yet but an imperfect method, and have by the narrow principles they were taught in the ſchools, been perſuaded to change their method rather to the barren principles of the Peripatetick ſchool, than to the full amplitude of nature. Nor do I find, that phyſicians have yet done ſo fit a thing, as ſeriouſly (and with the attention, which the importance of the thing deſerves) on the one ſide, to enumerate and diſtinguiſh the ſeveral cauſes, that may any whit probably be aſſigned, how the phænomena of that diſordered ſtate of the human body, which we call a diſeaſe, or its ſymptoms, may be produced; and on the other ſide, by how many and how differing ways the phænomena may be removed, or the diſeaſes they belong to deſtroyed: and if this were analytically and carefully done, I little doubt, but that men's knowledge of the nature and cauſes of diſeaſes, and the ways of curing them, would be leſs circumſcribed, and more effectual than now it is wont to be. And I am apt to think, that even methodiſts would then find, that there are divers probable, if not promiſing methods (proper to divers caſes) which ways they yet overlook. And though in a right ſenſe it be true, that the phyſician is but nature's miniſter, and is to comply with her, who aims always at the beſt; yet if we take them in the ſenſe thoſe expreſſions are vulgarly uſed in, I may elſewhere acquaint you with my exceptions at them, and in the mean time confeſs to you, that I know not whether they have not done harm, and hindered the advancement of phyſick, faſcinating the minds of men, and keeping them from thoſe effectual courſes, whereby they may potently alter the engine of the body; and by rectifying the motion and texture of its parts, both conſiſtent and fluid, may bring nature to their bent, and accuſtom her to ſuch convenient courſes of the blood and other juices, and ſuch fit times and ways of evacuating (what is noxious or ſuperfluous, *&c.*) as may prevent or cure divers ſtubborn diſeaſes, more happily than the vulgar methodiſts are wont to do.

And indeed, it is ſcarce to be expected, that till men have a better knowledge of the principles of natural philoſophy, without which it is hard to arrive at a more comprehenſive theory of the various poſſible cauſes or diſeaſes, and of the contrivance and uſes of the parts of the body, the method which ſuppoſes this knowledge ſhould be other than in many things defective, and in ſome erroneous; as I am apt to think, the vulgar method may be ſhewn to be, as to ſome particular diſeaſes. Of this I may perhaps elſewhere acquaint you more particularly with my ſuſpicions, and therefore I ſhall now only mention the laſt obſervation of this kind I met with, which was a gentleman, you and I very well know, who being for ſome months much troubled with a difficulty of breathing, and having been unſucceſsfully treated for it by very eminent phyſicians, we at laſt ſuſpected, that it was not the lungs, but the nerves, that ſerved to move the diaphragm and other organs of reſpiration, upon whoſe diſtemper this ſuppoſed aſthma depended: and accordingly, by a taking or two of a volatile ſalt of ours, which is very friendly to the *Genus nervoſum*, he was quickly freed from his troubleſome diſtemper, which afterwards he was fully perſuaded did not proceed from any ſtuffing up of the lungs. To be ſhort, how much eſteem ſoever we have for method, yet ſince that it ſelf and the theories whereon men ground it, are, as to divers particular diſeaſes, ſo hotly diſputed of, even among eminent phyſicians, that in many caſes a man may diſcern more probability of the ſucceſs of the remedy, than of the truth of the received notion of the diſeaſe; in ſuch abſtruſe caſes methinks it were not amiſs to reflect upon that reaſoning of the ancient empiricks (though on a ſomewhat differing occaſion) which is thus ſomewhere expreſſed by *Celſus: Neque ſe dicere conſilio medicum non egere, & irrationabile animal hanc artem poſſe præſtare, ſed has latentium rerum conjecturas ad rem non pertinere; quia non interſit, quid morbum faciat, ſed quid tollat.* ‘Nor doth he ſay, that a phyſician needs nothing of counſel or deliberation, or that an irrational man may profeſs this art; but that thoſe conjectures of hidden things are nothing to the purpoſe. Becauſe it matters not what cauſeth the diſeaſe, but what removes it.’ And as the controverted method in the above-mentioned diſeaſes is not yet eſtabliſhed or agreed on in the ſchools themſelves, ſo divers of thoſe, that are wholly ſtrangers to thoſe ſchools, do yet, by the help of experience and good ſpecificks, and the method their mother-wit does, according to emergencies, prompt them to take, perform ſuch conſiderable cures, that *Piſo* ſticks not to give this teſtimony to the utterly unlearned Braſilian empiricks: *Interim*, ſays he, *ſeniores & exercitatiores eximii ſunt botanici, facilique negotio omnis generis medicamina ex undiquaque in ſylvis conquiſitis conficiunt. Quæ tanta ſagacitate internè & externè illos adhibere videas, præcipuè in morbis è veneno natis, ut quis illorum manibus tutius & ſecurius ſe tradat, quam medicaſtris noſtris ſciolis, qui ſecreta quædam in umbra nata atque educata crepant perpetuò, & ob has rationales dici volunt.* ‘In the mean time, the Braſilian botaniſts make all ſorts of medicines of ſimples they find every where in the woods: which they make with ſo great ſagacity, and apply them both internally and externally, eſpecially to diſeaſes that ſpring from venom, that a man may more ſecurely give himſelf over to their hands, than to our unſkilful phyſicians, who brag much of ſecrets they have learnt in private, and for the knowledge of theſe will be called rationals in phyſick.’

Hiſt. Nat. & Med. lib. 2. pag. 23.

Inſtances of ſome medicines which are condemned for noxious, and yet have proved uſeful.

Secondly, There are divers medicines, which, though they want not ſome one quality or other, proper to increaſe the diſeaſe, againſt which they are adminiſtred, are yet confidently uſed by the moſt judicious doctors, becauſe that they are ſo inriched with other qualities, whereby they may do much more good than their noxious qualities can do harm: as in a malignant fever, though the diſtemper be hot, and though treacle and ſome other antidotal ſudorificks be hot alſo, yet they are uſefully adminiſtred in ſuch diſeaſes, becauſe the relief they bring the patient, by oppugning the malignity of the peccant matter, and perhaps by eaſing him of ſome of it by ſweat, is more conſiderable than the harm they can do him, by increaſing for a while his heat.

Cap. 2.

THE very experienced *Bontius*, chief phyſician to the *Dutch* plantation in the *Eaſt-Indies*, in his *Methodus medendi Indica*, treating of the ſpaſmus, which (though here unfrequent) he reckons among the endemical diſeaſes of the *Indies*, commends the uſe of *Quercetanus*'s laudanum, of philonium, and principally of an extract of opium and ſaffron, which he deſcribes and much extols: and leſt his readers ſhould ſcruple at ſo ſtrange a preſcription, he adds this memorable paſſage to our preſent purpoſe: *Fortaſſis* (ſays he) *ſciolus quiſpiam negabit his remediis, propter vim ſtupefactivam ac narcoticam nerviſque inimicam, eſſe utendum. Specioſa quidem hæc prima fronte videntur, ſed tamen vana ſunt. Nam præterquam quod calidiſſima hujus climatis temperies requirat, certiſſimum eſt in tali neceſſitate, ſine his ægrum evadere non poſſe. Adde, quod nos tam ritè opim hic præparamus, ut vel infanti innoxiè detur: & ſanè (ut verbo abſolvam) ſi opiata hic nobis deeſſent in morbis calidis his graſſantibus fruſtra remedia adhiberemus, quod etſi imperitis durum, ex progreſſu tamen me nil temere dixiſſe patebit.* ‘Perchance ſome ‘ſcioliſt in phyſick may affirm, that theſe things may not be uſed, by reaſon of the ‘narcotick and ſtupefactive property. But theſe pretences are as vain in effect as ‘ſpecious at firſt ſight: for beſides that the hot temper of this country requires it, it ‘is ſure, that without theſe remedies there can be no cure. Add, that here we ‘prepare opium ſo well, that you may give it to an infant. And truly, if in hot ‘diſeaſes we had no opiates, we ſhould in effect find, that the uſe of all other medi-‘caments would prove altogether vain and fruitleſs.’

Of the uſe of guaiacum for conſumptions, and mercury for palſies.

THE drinking freely, eſpecially if the drink be cold water, is uſually (and in moſt caſes, not without much reaſon) ſtrictly forbidden, as very hurtful for the dropſy; and yet thoſe, that frequent the *Spaw*, tell us of great cures performed by pouring in plenty of waters into the patient's already diſtended belly. And I know a perſon of great quality and virtue, who being by an obſtinate dropſy, beſides a complication of other formidable diſeaſes, brought to a deſperate condition, was adviſed to drink *Tunbridge*-waters, when I happened to be there, by her very ſkilful phyſician; who told me, that the doctors having done all their art could direct them unto, in vain, ſhe would be cured by death, if ſhe were not by theſe waters; from whence (the weather proving very ſeaſonable for that ſort of phyſick) ſhe returned in ſo proſperous a condition of recovery, as exacted both his and my wonder. That the decoction of ſo heating a ſimple as guaiacum would be looked upon by the generality of phyſicians, both Galeniſts and Chymiſts, as a dangerous medicine in phthiſical and other conſumptions, you will eaſily grant: and yet ſome eminent phyſicians, and (particularly Spaniards) tell us of wonderful cures they have performed in deſperate ulcers of the lungs, by the long uſe of this decoction, notwithſtanding its manifeſtly and troubleſomely heating quality. And I know a phyſician eminently learned, and much more a methodiſt than a chymiſt, who aſſures me, that he has made trial of this unlikely way of curing conſumptions with a ſucceſs, that has much recommended theſe paradoxical Spaniards to him. It is alſo believed, and not without cauſe, by phyſicians, that mercury is wont to prove a great enemy to the *genus nervoſum*, and often produces palſeys, and other diſtempers of the brain in the nerves: and yet one of the exacteſt and happieſt methodiſts I know, has confeſt to me, that mercurial preparations are thoſe, which he uſes the moſt ſucceſsfully in paralytical and the like diſtempers of, what phyſicians call, the *genus nervoſum*. And on this occaſion I remember, that a gentlewoman being confined to her bed by a dead-palſey, that had ſeized on one ſide of her body, a phyſician eminent for his books and cures, giving her a doſe of a certain preparation of mercury, corrected with a little gold, which I put into his hands for that purpoſe, was pleaſed to bring me word, that by the firſt taking of the powder, which wrought but gently by ſiege, without either vomits or ſalivation, ſhe was enabled the ſame or the next day to quit her bed, and walk about the room.

THIRDLY, there are many things, which ſeem to be againſt reaſon, whilſt they are barely propoſed and not proved, for which we afterwards diſcern very good reaſon; when experience having ſatisfied us they are really true, has both invited us, and aſſiſted us, to inquire into their cauſes. Of this we have elſewhere given divers not medical inſtances in our eſſay *concerning improbable truths:* and I could eaſily enough, if I durſt be tedious, give you ſome medical illuſtrations of the ſame truth. But I dare now only to invite you to conſider this one thing, which may be of great uſe to explicate many others, both in natural philoſophy, and in phyſick too; which is, that there are divers concretes, ſome of them, as to ſenſe, ſimilar, or homogeneous, whoſe differing parts are endowed with very differing and ſometimes contrary qualities. And this not only appears in the chymical analyſis of bodies made by the fire, where the difference of what chymiſts call the ſeparated principles of concretes, is often very manifeſt and great, but even in divers bodies, that have not been reſolved by the violence of the fire; as is evident in rhubarb taken in ſubſtance, whoſe ſubtiler parts are purging, and its terreſtrial aſtringent. Nay, if thoſe parts, which do in much the leſs quantity concur to the conſtitution of the concrete, do but meet with a body diſpoſed to receive their impreſſions, it is very poſſible, that they may work more powerfully on it than the other parts of the ſame concrete, of which the eye judgeth it altogether to conſiſt.

That there are divers concretes as to ſenſe, ſimilar, whoſe different parts have contrary qualities; as rhubarb and oil-olive.

THIS I have made out to ſome ingenious men, by ſhewing, that though ſallad-oil be generally reputed to conſiſt of fat and unctuous particles, and therefore to be a great reſiſter of corroſion; yet it contains in it ſharp and piercing parts, which meeting with a diſpoſed ſubject, do more powerfully operate, than the purely oleaginous ones. As we endeavoured to evince, by keeping for a ſhort while, in a gentle warmth, ſome pure oil-olive, upon a quantity of filings of even crude copper: for from them the liquor extracted an high tincture betwixt green and blue, like that, which ſuch filings would have given to diſtilled vinegar, which, according to chymiſts notions, obtains that colour, by making with its acid and corroſive ſalt a real ſolution of ſome part of the copper, as may appear by the recoverableneſs of the metal out of it. Another proof or two of the acrimony of ſome of the parts of oil, we may elſewhere give you. But now we ſhall rather confirm our anſwer to your queſtion, by two or three examples of cures performed by unlikely remedies.

Of improbable cures, viz. of a laudanum opiatum.

I WENT once to viſit an ingenious Helmontian, whom I found ſick on his bed; and having by the ſymptoms of his diſeaſe diſcerned it to be a pleuriſy, I talked with him of ſeaſonably opening a vein, but he was reſolved againſt it; and told me he would cure himſelf by a remedy, which at firſt ſeems as likely to increaſe ſuch a diſeaſe as phlebotomy is to cure it; namely, by the uſe of *Helmont*'s *laudanum opiatum*, which in effect did in three or four days cure him, and ſince, he, without blood-letting, cured ſome others with it: which I the leſs wonder at, becauſe of my having obſerved, that opium (with which unſkilful men ſeldom tamper without danger) if duly corrected and prepared, proves ſometimes a great reſolver, and commonly a great ſudorifick; inſomuch, that I have known it make a perſon copiouſly ſweat, who often complained to me, that other diaphoreticks had no ſuch operation on him.

I HAVE oftentimes ſeen coughs ſtrangely abated by the uſe of a remedy, which I have not long ſince told you how I prepare; and with which (I remember) in a pretty child you, *Pyrophilus*, know, and who is now very well, I was ſo happy as to repreſs

Of curing coughs and conſumptions by ſaline medicines.

repreſs in a few hours a violent cough, that threatned her with ſpeedy death; and yet this medicine has ſo eminent a ſaltneſs, that the tongue can ſcarce ſuffer it: and how much the uſe of ſalt things, is by many phyſicians condemned in coughs, (and indeed in many caſes not without reaſon) I need not tell you. And with exceedingly piercing eſſence or ſpirit of man's blood, I have known, notwithſtanding its being very ſaline, and its manifeſtly heating the patient, eſpecially for the firſt four or five days, ſtrange things performed, even in a deplorable and hereditary conſumption. This, *Pyrophilus*, brings into my mind ſomething, that, it may be, you will think odd: which is, that having had occaſion to adviſe, for a perſon of high quality, with a very ancient Galeniſt, that in his own country was looked upon as almoſt an oracle, and particularly in reference to phthiſical conſumptions, which was there a vulgar diſeaſe; he confeſſed to me, that although his having fallen into it himſelf, made him very ſolicitous to find a cure for it; and though he had, in his long and various practice, made trial of great variety of methods and remedies for the cure of that diſeaſe, yet that, with which he cured himſelf, and afterwards the generality of his chief patients, was principally ſulphur melted and mingled in a certain proportion to make it fit to be taken, in a pipe, with beaten amber or a cephalick herb. The particular circumſtances of his method I cannot now ſet you down, not having by me the paper, wherein they were noted; but, if I miſtake not, the herb, with which he mingled the brimſtone of flour of ſulphur, was colts-foot or betony; and I well remember, that what he looked upon as the chief and ſpecifick remedy in his way of curing, was the ſmoke of the ſulphur; the other ingredients being added, not ſo much for their being proper enough for the diſeaſe, as their helping to fill the pipe, and thereby to allay the pungency, wherewith the ſmoke, if afforded by a pipe filled with brimſtone alone, would be qualified. But yet this ſulphureous ſmoke is ſo predominant in the remedy, that he uſed to have a ſyrup in readineſs to relieve thoſe, whom the acrimony of the fumes ſhould make very ſore, and perhaps bliſter on the one ſide of their mouths, or throats; which accident he provided for, by that cooling and healing ſyrup, without being thereby diſcouraged from proſecuting the cure with the ſame remedy; wherewith a perſon, very curious and rich, has ſolemnly aſſured me, that himſelf has cured divers conſumptions, and particularly in a lady, even in health very lean, that he named to me, as being one I then knew. Now we know, that phyſicians generally, and in moſt caſes juſtly, forbid acid things to thoſe, that have exulcerated or tender lungs; and how highly acid and piercing the ſmoke of ſulphur is, the chymiſts can beſt tell you, who, by catching it, and condenſing it in glaſſes ſhaped almoſt like bells, obtain from it that very corroſive liquor, which readily diſſolves iron, being the very ſame, that is commonly called *Oleum ſulphuris per campanam:* and yet it ſeems, that either the theory of conſumptions is miſunderſtood, or that the drying quality of the ſulphureous ſteam, and its great power to reſiſt putrefaction, and as it were embalm the lungs and ſeaſon the blood, are conſiderable enough to account for the harm, which its acidity may do.

Of the curing phthiſical conſumptions by the acid ſmoke of ſulphur.

The uſe of the livers and galls of eels in expediting the hard labour of women.

EELS are ſo commonly eaten by perſons of both ſexes, without being taken notice of for any quality, except their crudity, that one would ſcarce believe ſuch a ſtinking and odious medicine, as that of their livers and galls, dried ſlowly in an oven, ſhould be more proper for any thing, than to make the taker vomit: and yet *Helmont* in divers places ſpeaks of the medicine, as if it had kept multitudes of women from dying of hard labour. And ſince him, *Panarola* in his *New Obſervations* highly extols it. And I knew a very famous empirick, who had very few other ſecrets, and ſcarce any one ſo great to get reputation and money by. And I remember alſo, that ſome years ſince I had occaſion to give it to the wife of a very ingenious phyſician, of whom the midwives and her huſband almoſt deſpaired, and (as ſhe afterwards told me her ſelf) each doſe made her throws (which before had left her) return; and at length ſhe was ſafely delivered, ſhe ſcarce knew how. But I found double the doſe preſcribed by *Helmont* requiſite to be uſed at laſt, and that the quantity of a walnut of the powder of theſe livers given in Rheniſh or white-wine, and when the ſtomach was moſt empty, was no more than ſuch a caſe required.

The unlikely cure of venom by oil of ſcorpions.

SCORPIONS being venomous creatures, to ſuffocate and infuſe them in oil, might ſeem the way to make it poiſonous; if experience did not aſſure us, that this oil is ſo far from being ſuch, that it cures the invenomed bitings of ſcorpions; which effect, now that the phyſicians find it upon trial to be true, they confeſs to be rational; and aſcribe it, how juſtly I now examine not, to the attraction of the poiſon received into the body by that, which is outwardly applied to the hurt. And *Piſo* informs us, that amongſt the Braſilians, whoſe country is ſo much infeſted with venomous creatures, it is the moſt general cure to draw out the poiſon, by applying to the hurt the beaten body of the beaſt, that gave it. As likewiſe in *Italy*, they account the cruſhing of the very ſcorpion, that has bit a man, upon the bitten place, for a moſt ſpeedy and effectual remedy. And I remember, that here in *England* the old man, whom you have ſeen going about with vipers, toads, *&c.* to ſell, told me, that when he was dangerouſly bitten by a viper, and all ſwelled by the poiſon of it; a great part of his cure was the outward application of venomous creatures, ſtamped till they were brought to a conſiſtence fit for that purpoſe.

THAT fluxes are the general and endemical diſeaſes in *Ireland*, I need not tell you; and yet I remember, that having occaſion to conſult the ancienteſt and moſt experienced phyſician of that nation, Dr. *F.* about the cure of it, he aſſured me, that though during his very long practice he had found divers remedies very proſperous, ſome on one ſort of patients, and ſome on another; yet the medicine he moſt relied on, was this: To take unſalted butter, and boil it gently till a pretty part was conſumed; ſkimming it diligently from time to time, whilſt it ſtands over the fire; and of this butter melted, to give now and then a conſiderable quantity, according as the patient is able to bear it. A remedy, which, at the firſt propoſal, may ſeem more likely to put a man into a flux, than to cure him of one. And yet the ſame remedy, which, he ſuppoſed to benefit by mitigating the ſharp humours, and preſerving the entrails from their corroſion, was afterwards much commended to me by another ancient *Iriſh* phyſician, who was eſteemed among the doctors the next in eminency to him that I have named.

And of fluxes by freſh butter melted.

## CHAP. XIX.

I SHOULD not here, *Pyrophilus*, add any thing to what I have already ſaid above in favour of the uſe of even odd ſpecificks, but, that finding at every turn, that the main thing, which does (really or in pretence) prevail with many learned phyſicians (eſpecially in a famous univerſity you have viſited abroad) to reject ſpecificks, is, that they cannot clearly conceive the diſtinct manner of the ſpecificks working; and think it utterly improbable, that ſuch a medicine, which muſt paſs through digeſtions in the body, and be whirled about with the maſs of blood to all the parts, ſhould, neglecting the reſt, ſhew it ſelf friendly to the brain (for inſtance) or the kidneys, and fall upon this or that juice or humour rather than any other. But to this objection, which I have propoſed as plauſible as I can readily make it, I ſhall at preſent but briefly offer, according to what has been hitherto diſcourſed, theſe two things.

That it is very hard to give an intelligible explication of the operation of electives, and other common medicaments, which are not ſpecificks.

AND firſt, I would demand of theſe objectors a clear and ſatisfactory, or at leaſt an intelligible explication of the manner of working of divers other medicaments, that do not paſs for ſpecificks; as how rhubarb purges choler, and hellebore melancholy rather than other humours; how ſome medicines, that have endured a ſtrong fire, as *Antimonium diaphoreticum*, and *Bezoardicum minerale* well made, are yet oftentimes ſtrongly ſudorifick; why the infuſion of *Crocus metallorum* or of glaſs of antimony, though it acquire no pungent, or ſo much as manifeſt taſte, whereby to vellicate the palate or the tongue, are yet violently both vomitive and cathartick; and how mercury, which is innoxiouſly given in many caſes crude to women in labour and others, does eaſily acquire, beſides many other more abſtruſe medicinal qualities, not only an emetick or purgative, but a ſalivating faculty. For I confeſs, that to me, even many of the vulgar operations of common drugs ſeem not to have been hitherto intelligibly explained by phyſicians, who are yet, for aught I have obſerved, to ſeek for an account of the manner, how diureticks, how ſudorificks, how ſarcoticks, and how many other familiar ſorts of medicines, which thoſe, that conſider them ſlightly, are wont to think they underſtand thoroughly, perform their operations. Nay, I much queſtion, whether the generality of phyſicians can yet give us a ſatisfactory account, why any ſort of medicine purges in general: and he, that in particular will ſhew me, where either the peripatetick, or Galenical ſchools, have intelligibly made out, why rhubarb does particularly purge choler, and ſenna more particularly phlegm, *erit mihi magnus Apollo*. For I ſee not how from thoſe narrow and barren principles of the four elements, the four humours, the four firſt qualities (and the like) effects, far leſs abſtruſe than the operations of purging medicines, can ſatisfactorily be deduced. Nor can I find, that any thing makes thoſe phyſicians, that are unacquainted with the philoſophy, that explains things by the motions, ſizes, and figures of little bodies, imagine they underſtand the account, upon which ſome medicines are purgative, others emetick, *&c.* and ſome purgative in ſome bodies, vomitive in other, and both purgative and vomitive in moſt; but becauſe they never attentively inquire into it.

BUT (which is the next thing I have to repreſent) if we duly make uſe of thoſe fertile and comprehenſive principles of philoſophy, the motions, ſhapes, magnitudes and texture of minute parts of matter; it will not perhaps be more difficult to ſhew, at leaſt in general, that ſpecificks may have ſuch operations, as are by the judicious and experienced aſcribed to them, than it will be for thoſe, that acquieſce in the vulgar principles of philoſophy and phyſick, to render the true reaſons of the moſt obvious and familiar operations of medicines. And though the ſame objection, that is urged to prove, that a ſpecifick cannot befriend the kidneys, for example, or the throat rather than any other parts of the body, lies againſt the noxiouſneſs of poiſons to this or that determinate part; yet experience manifeſts, that ſome poiſons do reſpect ſome particular part of the body, without equally (if at all ſenſibly) offending the reſt: and we ſee that cantharides in a certain doſe are noxious to the kidneys and bladder, quickſilver to the throat, and the glandules thereabouts, ſtrammonium to the brain, and opium to the animal ſpirits and genus nervoſum. And if you call to mind, what we have formerly deduced to make it out, that a human body is an engine, and the medicines operate in it as finding it ſo; we need not think it ſo ſtrange, that there being many ſtrainers, if I may ſo call them, of differing textures, ſuch as the liver, ſpleen, and kidneys, and perhaps divers local ferments reſiding in particular parts, and a maſs of blood continually ſtreaming through all the parts of the body, a medicine may be quickly, by the blood, carried from any one part to any other, and the blood, or any humour mingled with it, may be as eaſily carried to the

That poiſons do reſpect particular parts, and therefore medicines may do it.

General explications of the manner, how theſe operations of ſpecificks may proceed.

the medicine, in what parts ſoever it be; and the remedy thus admitted into the maſs of blood may, in its paſſage through the ſtrainers, be ſo altered, either by leaving ſome of its parts there, or by having them altered by the abovementioned ferments, or by being aſſociated with ſome other corpuſcles, it may meet with in its paſſage; whereby the ſize, or figure, or motion of its ſmall parts may be changed; or, in a word, it may by ſome of thoſe many other ways, which might, if this eſſay were not too prolix already, be propoſed and deduced, receive ſo great an alteration, in reference either to ſome or other of the ſtrainers, or other firmer parts of the body, or to the diſtempered blood, or ſome other fluid and peccant matter, that it needs not ſeem impoſſible, that by that time the medicine (crumbled as it were in minute corpuſcles) arrives at the part or humour to be wrought upon, it may have a notable operation there. I mean *part* as well as *humour*, becauſe the motion, ſize, or ſhape of the medicinal corpuſcles in the blood, though not by ſenſe diſtinguiſhable from the reſt of the liquor they help to compoſe, may be ſo conveniently qualified, as to ſhape, bulk, and motion; as to reſtore the ſtrainers to their right tone or texture, as well as the blood to its free and natural courſe; by reſolving and carrying away with them ſuch tenacious matter, as ſtuffed or choaked up the ſlender paſſages of the ſtrainer, or at leaſt ſtraitned its pores, or vitiated their figure. And the ſame ſanative corpuſcles may perchance be alſo fitted to ſtick to, and thereby to ſtrengthen ſuch fibres of the ſtrainers, or ſuch other firmer parts of the body, as may need congruous corpuſcles to fill up their little unſupplied cavities.

MEATS, that are ſalt, and tartareous, whilſt they are whirled about in the maſs of blood, may by the other parts of that vital liquor be ſo diluted and kept aſunder ſo, as not to be offenſive to any part: when they come to be ſeparated by the parenchyma of the kidneys, from the ſweeter parts of the blood, that did before temper and allay them, they eaſily, by their ſaline pungency, offend the tender ureters and membranous bladders of thoſe, that are troubled with the ſtone or ſtrangury. And perchance it is upon ſome ſuch account, that cantharides are more noxious to the bladder than to other parts of the body. And as ſalt meat thus grows peculiarly offenſive to the reins and bladder; ſo a ſpecifick, diſpoſed to be diſſolved, after a peculiar manner, may, in the body, either preſerve or acquire, as to its minute parts, a friendly congruity to the pores of the kidneys, liver, or other ſtrainers equally, when diſtempered; as I formerly obſerved to you, that new-milk ſweetened with ſugar-candy, though it be not wont ſenſibly to affect any other part of the body, nor would have ſenſibly affected the kidneys themſelves, had they not been diſordered: yet after the troubleſome operation of cantharides, it had a very friendly effect upon the diſtempered parts. Thus a ſpecifick for one diſeaſe may be reſolved in the body into minute particles of ſuch figure and motion, that being fit to ſtick to other corpuſcles of peccant matter, which, by their vehement agitation, or other offenſive qualities diſcompoſe the body and make it feveriſh, may allay their vehement motion, and by altering them, as to bigneſs and ſhape, give them new and innocent qualities, inſtead of thoſe noxious ones they had before.

ANOTHER ſpecifick may diſſolve the groſs and ſlimy humours, that obſtruct the narrow paſſages of the veins; as I have obſerved, that ſpirit of harts-horn, which powerfully opens other obſtructions, and reſolves ſtuffing phlegm in the lungs, will alſo, though more ſlowly, reſolve prepared flowers of ſulphur, crude copper, and divers other bodies; and alſo it may, by mortifying the acid ſpirit, that oftentimes cauſes coagulations in the blood, reſtore that vital liquor to its fluidity and free circulation, and thereby remove divers formidable diſeaſes, which ſeem to proceed from the coagulation or ropineſs of the blood; and, on the other ſide, the minute parts of ſome ſpecificks againſt a contrary diſeaſe may ſomewhat thicken and fix the too thin and agitated parts of the blood, or of ſome peccant matter in it, by aſſociating themſelves therewith; as the nimble parts of pure ſpirit of wine, and thoſe of high rectified ſpirit of urine, will concoagulate into corpuſcles, bigger and far leſs agile. And the ſame ſpirit of wine it ſelf, with another liquor I make, will preſently concoagulate into a kind of ſoft, but not fluid ſubſtance. Nor is it ſo hard to conceive, that a ſpecifick may work upon a determinate part or humour, and let the others alone: as if you put, for inſtance, an egg into ſtrong vinegar, the liquor will operate upon and diſſolve all the hard ſhell, and yet leave the tender ſkin untouched. And if you caſt coral into the common rectified ſpirit of tartar, the far greater part of the liquor, though ſtrong and ſpirituous, will remain unaltered thereby, and may be, *integris viribus*, abſtracted from it; but the coral will preſently find out, or rather be found out by acid or acetous particles, and by incorporating it ſelf with them, take away their ſharpneſs: as in ſome caſes coral has been obſerved to do to ſour humours abounding in human bodies, thoſe humours being eaſily, by the circulating blood, brought (in their paſſage) to the coral, whilſt it perhaps remains in the ſtomach or guts. And though the circulation of the blood be ſufficient to bring, little by little, the acid particles of that liquor in its paſſages through the veſſels to work upon coral; yet in other medicines the operation may be more nimble, the remedy quickly diffuſing it ſelf through the maſs of blood, to ſeek, as it were, and deſtroy the acid parts, which it meets with blended with the reſt of the liquor. As ſpirit of urine being, inſtead of coral, put into the above mentioned ſpirit of tartar, will not (that I have obſerved) faſten itſelf to the ſpirituous nor the phlegmatick parts of the liquor, but only to the acid ones, which it will mortify or deprive of their ſourneſs by concoagulating with them. And I ſee not, why it ſhould be more inconceivable, that a ſpecifick ſhould have a peculiar virtue to free the body from this or that peccant humour, and a benign congruity to the diſtempered ſpleen or liver, than that ſome cathartick ſhould purge electively, and ſome antidotes have peculiar virtues againſt ſuch poiſons, whoſe malignity particularly invades the brain or kidneys, or ſome other determinate part: the former of which the phyſicians, we reaſon with, ſcruple not to teach; and the latter of which is taught us not by them only, but by experience too.

That vinegar will operate on the ſhell, and not upon the other parts of the egg; with like inſtances of ſpecifick operations.

[OF the credibility of ſpecificks, and of the efficacy even of ſome unlikely ones, we might eaſily enough preſent you with more proofs and examples: but theſe may poſſibly be ſufficient for our preſent purpoſe; eſpecially, if you duely conſider, that as phyſick had owed its beginning to experience, ſo thoſe, that practiſe it, muſt enlarge and rectify their principles according to the new diſcoveries, which are made from time to time of the operations and power of the productions whether of nature or of art. This conſideration I thought to inſiſt upon in my own expreſſions; but finding lately the ſame notion, which I had, to have been long ſince that of the ancient empiricks, I will ſum up what I meant to ſay, in their words, as I find them wittily delivered by *Celſus*, in that excellent preface, where having ſpoken in their ſenſe of the origin of phyſick, he continues, *Sic medicinam ortam, ſubinde aliorum ſalute, aliorum interitu pernicioſa diſcernentem à ſalutaribus: repertis deinde medicinæ remediis, homines de rationibus eorum diſſerere cœpiſſe; nec poſt rationem, medicinam, eſſe inventam, ſed poſt inventam medicinam, rationem eſſe quæſitam* ‘Such was the origin of phyſick: by the recovery of ſome, ‘and the death of others, it firſt made diſtinction between things ſovereign to heal, and ‘things which are improper and deadly. And thus the remedies being found out, men ‘began to diſpute of the reaſons of them. Nor was the art of medicine found out by the ‘light of reaſon; but, medicine being found, the reaſon began to be inquired into.’ And leſt the miſtaken name of empirick ſhould make you undervalue ſo uſeful a con-

That phyſick, as it begun by experience, ſo it muſt be enlarged and rectified by the new diſcoveries of experience.

ſideration, which not the nature of their ſect, but that of the thing, ſuggeſted to them; I ſhall add, in favour of what we have delivered concerning experienced, though otherwiſe unlikely remedies, that it is a ſentence aſcribed to *Ariſtotle* (and, in my opinion, one of the beſt, that is aſcribed to him) *Ubi res conſtat, ſi opinio adverſetur rei, quærendam rationem, non rem ignorandam.* 'Where the matter is certain, if it 'be againſt the common opinion, the reaſon muſt be ſought, and not the matter 'of fact ſcrupled.'

AND certainly, *Pyrophilus*, though there be ſcarce any ſort of men, whoſe credulity may do the world more miſchief than that of phyſicians; yet perhaps, neither nature, nor mankind is much beholden to thoſe, that too rigidly, or narrowly, circumſcribe, or confine the operations of nature, and not ſo much as allow themſelves or others to try, whether it be poſſible for nature, excited and managed by art, to perform divers things, which they never yet ſaw done, or work by divers ways, differing from any, which by the common principles, that are taught in the ſchools, they are able to give a ſatisfactory account of.

**That the operations of the antimonial cup, glaſs of antimony, and crocus metallorum, would not have been credited in ancient times.**

To the many things, which you may be pleaſed to apply to this purpoſe out of the precedent diſcourſe, divers others may be added, if, without tiring you, they may be now inſiſted on. It would ſcarce have been believed ſome ages ſince, by thoſe, that knew no other than vegetable purges and vomits, that a cup made of a concrete, inſuperable by the heat of human ſtomachs, ſhould, by having for a while, wine, or any ſuch other liquor, barely poured on it, to make an infuſion, without any ſenſible diminution of its own bulk or weight, and without any ſenſible alteration made in the colour, taſte or ſmell of the wine, communicate to it a ſtrongly emetick and cathartick virtue, and prove oftentimes vomitive, even when put up in the clyſters; and yet that this is performable by antimony, ſlightly prepared with ſalt-petre, or without addition, melted into a tranſparent glaſs, is commonly known to thoſe, that are not ſtrangers to the operations of the antimonial cup, and of the glaſs made of the ſame mineral. And much more ſtrange is that, which is affirmed by inquiſitive phyſicians upon their own trial of the common *crocus metallorum*, or ſomewhat corrected antimony wont to be ſold in ſhops; namely, that a few drachms of it, infuſed into ſome ounces of wine, will make the liquor work ſo ſtrongly, as if ſix or eight times the quantity had been ſteeped in it.

THOSE that believe, that all diaphoreticks muſt conſiſt of ſubtile, ſapid, and fugitive parts, as if only ſuch were eaſily ſeparated from each other, and agitated by the gentle heat of a human body, will ſcarce expect, that any body could, in a moderate doſe, be a good ſudorifick, that is ſo fixt as to be able to perſiſt divers hours in a good fire. And yet that *Antimonium diaphoreticum* is ſuch a concrete, is now very well known to many beſides chymiſts.

THAT a ſtone, and a ſtone too ſo fixed, that will ſuſtain the violence of reverberated fire, and is conſequently very unlikely to be much wrought upon, or digeſted by the heat of a human ſtomach, ſhould be capable of agglutinating together the parts of broken bones, would ſeem impoſſible to many; but it is very well known to thoſe, that have made trial of the efficacy of the *Lapis oſſifragus*. For though I have ſometimes wondered at the fixedneſs of this ſtone above others in the fire, yet being for ſome days ſucceſſively drunk in wine, or aqua ſymphyti, to the quantity of about half a drachm, or more, it doth ſo wonderfully cement together the parts of broken and well-ſet bones, that it deſerves the name it commonly hath in the ſhops of *Oſteocolla*, and hath wonders related of it by ſeveral eminent, not only chymical, but Galenical writers.

**Divers other inſtances alike incredible.**

IT is almoſt incredible what *Quercetan* relates, of what himſelf ſaw done with it as to the cure of broken bones, without much pain, or any of the uſual grievous ſymptoms, within four or five days; ſo that to the ſtupendous virtue he aſcribes to this ſtone, both inwardly given, and outwardly applied in the form of a pultis, with only beaten geranium and oil of roſes or olives, he thinks fit to annex theſe words: *Quod incredibile videri poſſet, niſi præter me innumerabiles alii oculati & idonei teſtes extarent.* And indeed theſe need good proof to make a wary man believe ſo ſtrange a thing, ſince ſurgeons obſerve, that nature is wont to be forty days in producing a callus to faſten together the pieces of a broken bone. But to make this the more credible by the teſtimony of authors more Galenically inclined, *Mathiolus* relates, that in many the bones having been very well ſet (which circumſtance he requires as neceſſary) have had their broken parts conglutinated within three or four days. And not only that moſt experienced ſurgeon *Fabricius Hildanus* uſed it much in fractures, with only a little cinnamon and ſugar to make it pleaſant; but the learned *Sennertus*, who ſomewhere calls its virtue admirable, thinks it requiſite, in his ſurgery, to give us this caution of it: *Verum in juvenibus, & iis qui boni ſunt habitus, callum nimis auget; quapropter cautè & non niſi in adultioribus exhibendus.* The warrantableneſs of which caution, and conſequently the ſtrange efficacy of oſteocolla, as, I remember, confirmed to me not long ſince by a ſkilful phyſician, who hath particularly ſtudied its nature, and related to me, that ſome years ſince his mother, having by a fall broken her leg near the knee, had too ſuddenly, by the overmuch uſe of this ſtone, a callus produced in the part much bigger than he expected or deſired.

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Cap. 1.

He that, before the ſalivating property of mercury was diſcovered, ſhould have told phyſicians of the deſpondent temper of theſe, we are now diſcourſing with, that beſides the known ways of diſburthening nature, (namely, by vomit, ſiege, urine, ſweat, and inſenſible tranſpiration) there were a ſort of remedies, that would make very large evacuations by ſpittle, and thereby cure divers ſtubborn diſeaſes, that had been found refractory to all ordinary remedies, would certainly have been more likely to be derided than believed by them; ſince no known remedy, beſides mercury, hath been, that I remember, obſerved to work regularly by ſalivation. For though ceruſs of antimony have been obſerved to make men, of ſome conſtitutions, apt to ſpit much, yet it works that way too languidly, to deſerve the name of a ſalivating remedy, and probably oweth the quality it hath of inclining to ſpit, to the mercurial part of the antimony, (wherewith the regulus, it is made of, abounds) and therefore the greater their experience of the effects of medicinal operations ſhould be ſuppoſed to be, the greater indiſpoſition it would give them to credit ſo unallied a truth. And yet the reality of the fluxing property of quickſilver is long ſince grown paſt queſtion, and hath been found ſo uſeful in the cure of the moſt radicated and obſtinate venereal diſtempers, that I ſomewhat wonder thoſe phyſicians, that ſcruple not to employ as boiſterous ways of cure, have not yet applied it to the extirpation of ſome other diſeaſes; as ulcers of the kidneys, conſumptions, and even palſies, *&c.* wherein I am apt to think it may be as effectual, as in thoſe produced by luſt, and much more effectual than vulgar remedies, provided that the exceeding troubleſome way of working of ſalivating medicines be better corrected, than it is wont to be in the ordinary medicines employed to produce ſalivation, which they do with ſuch tormenting ſymptoms, that they are ſcarcely ſupportable. But if purified quickſilver be dexterouſly precipitated by a long and competent digeſtion, with a due proportion of refined gold, experience hath informed us, that the ſalivating operation of it may be performed with much leſs uneaſineſs to the patient. And that ſuch mercurial medicines, wherein the quickſilver is well corrected by gold, may produce more than ordinary effects, we have been inclined to believe, by the trials, which we procured by learned phyſicians to be made in other than venereal diſeaſes, of a gently working precipitate of gold and mercury, of which we may elſewhere ſet you down the proceſs.

A ſtrange cure of blindneſs by a mercurial powder.

[AND now I am upon the diſcourſe of the peculiar operations of mercury, and of unuſual ways of evacuation, I am tempted to ſubjoin an odd ſtory, which may afford notable hints to a ſpeculative man, as it was related to me both in private, and before illuſtrious witneſſes, by the formerly commended chymiſt of the French king: he told me then a while ſince, that there is yet living a perſon of quality, by name Monſieur *de Vatteville*, well known by the command he hath or had of a regiment of *Switzers* in *France*, who, many years ago following the wars in the Low Countries, fell into a violent diſtemper of his eyes, which, in ſpite of what phyſicians and ſurgeons could do, did in a few months ſo increaſe, that he loſt the uſe of both his eyes, and languiſhed long in a confirmed blindneſs; which continued till he heard of a certain empirick at *Amſterdam*, commonly known by the name of *Adrian Glaſmaker* (for indeed he was a glazier) who being cried up for prodigious cures he had done with a certain powder, this colonel reſorted to him, and the empirick having diſcourſed with him, undertook his recovery, if he would undergo the torment of the cure: which the colonel having undertaken to do, the ſurgeon made him ſnuff up into each noſtril about a grain of a certain mercurial powder, which in a ſtrangely violent manner quickly wrought with him almoſt all imaginable ways, as by vomit, ſiege, ſweat, urine, ſpitting, and tears, within ten or twelve hours that this operation laſted, making his head alſo to ſwell very much; but within three or four days after this ſingle taking of the draſtick medicine had done working, he began to recover ſome degree of ſight, and within a fortnight attained to ſuch a one, that he himſelf aſſured the relater, he never was ſo ſharp-ſighted before his blindneſs. And the relater aſſured me, that he had taken pleaſure to obſerve, that this gentleman, who is his familiar acquaintance, would diſcern objects farther and clearer than moſt other men. He added, that Monſieur *de Vatteville* told the relater, he had purchaſed the way of making this powder of the empirick, and had given it to an eminent ſurgeon, one *Benoeſt* (an acquaintance of the relater's) by whom he had been cured of a muſket ſhot, that had broken his thigh-bone, when the other ſurgeons would have proceeded to amputation; and that this *Benoeſt* had with this powder, adminiſtred as before is related, cured a gentlewoman of a cancer in the breaſt. All which, and more, was confirmed to the relater by the ſurgeon himſelf. But in what other ſtubborn and deplorable caſes they uſe this powder, I do not particularly remember. The preparation of it, which a chymiſt did me the favour to tell me by word of mouth, as a thing himſelf had alſo made, was in ſhort this: that the remedy was made by precipitating quickſilver with good oil of vitriol, and ſo making a turbith, which is afterwards to be dulcified by abſtracting twenty or twenty five times from it pure ſpirit of wine, of which freſh muſt be taken at every abſtraction. But I would not adviſe you to commend ſo furious a powder to any, that is not a very ſkilful chymiſt and phyſician too, till you know the exact preparation, and particular uſes of it; the reaſon of my mentioning it here, being but that, which I expreſſed at the entrance upon this narrative.]

## CHAP. XX.

Of univerſal medicines.

YOU will perchance wonder, *Pyrophilus*, that having had ſo fair an opportunity as the ſubject of this eſſay afforded me, of diſcourſing to you about the univerſal medicine, which many Paracelſians, Helmontians, and other chymiſts talk of ſo confidently: I have ſaid nothing concerning the exiſtence, or ſo much as the poſſibility of it. But till I be better ſatisfied about thoſe particulars than yet I have been, I am unwilling either to ſeem to believe what I am not yet convinced of, or to aſſert any thing, that may tend to diſcourage human induſtry; and therefore I ſhall only venture to add on this occaſion; that I fear we do ſomewhat too much confine our hopes, when we think, that one generous remedy can ſcarce be effectual in ſeveral diſeaſes, if their cauſes be ſuppoſed to be a little differing. For the theory of diſeaſes is not, I fear, ſo accurate and certain, as to make it fit for us to neglect the manifeſt or hopeful virtues of noble remedies, wherever we cannot reconcile them to that theory. He that conſiders what not unfrequently happens in diſtempered bodies by the metaſtaſis of the morbifick matter, (as for inſtance, how that, which in the lungs cauſed a violent cough, removed up to the head may produce, as we have obſerved, a quick decay of memory and ratiocination, and a palſy in the hands and other limbs) may enough diſcern, that diſeaſes, that appear very differing, may eaſily be produced by a peccant matter of the ſame nature, only variouſly determined in its operations by the conſtitution of the parts of the body where it ſettleth: and conſequently it may ſeem probable to him, that the ſame ſearching medicine, being endowed with qualities deſtructive to the texture of the morbifick matter, where-ever it finds it, may be able to cure either all, or the greateſt part, of the diſeaſe, which the various tranſlation of ſuch a matter hath been obſerved to beget. Moreover, it oftentimes happens, that diſeaſes, that ſeem of a contrary nature, may proceed from the ſame cauſe variouſly circumſtanced; or (if you pleaſe) that of divers diſeaſes, that may both ſeem primary, the one is but ſymptomatical, or at moſt ſecondary in relation to the other; as a dropſy and a ſlow fever may, to unſkilful men, ſeem diſeaſes of a quite contrary nature, (the one being reputed a hot and dry, the other a cold and moiſt diſtemper) though expert phyſicians know they may both proceed from the ſame cauſe, and be cured by the ſame remedy. And in women experience manifeſts, that a great variety of different diſtempers, which by unſkilful phyſicians have been adjudged diſtinct and primary diſeaſes, and have been, as ſuch, unſucceſsfully dealt with by them, may really be but diſguiſed ſymptoms of the diſtempers of the mother or *genus nervoſum*; and may by remedies, reputed antihyſterical, be happily removed. To which purpoſe I might tell you, *Pyrophilus*, that I, not long ſince, knew a practitioner, that with great ſucceſs uſed the ſame remedies (which were chiefly volatile and reſolving ſalts) in dropſies, and in (not, ſymptomatical, but) eſſential fevers. And our ſelves have lately made ſome experiments of not much unlike nature, with a preparation of hartſhorn, of equal uſe in fevers and coughs, both of them primary. I might on this occaſion recur to divers of the remedies formerly mentioned in ſeveral places of this eſſay; ſince divers of them have been found effectual againſt diſeaſes, which, according to our common theory, ſeem to be little of kin one to another: and by telling you what I have obſerved concerning the various operations of *Helmont*'s *laudanum*, of our *ens veneris*, and even of a medicine deviſed by a woman, the lady *Kent*'s powder, I might illuſtrate what I have lately delivered: but it is high time for me to paſs on to another ſubject; and therefore I ſhall rather deſire you, in general, to conſider, whether or no ſeveral differing diſeaſes, and even ſome commonly ſuppoſed to be of contrary natures, be not yearly cured by the *Spaw* waters in *Germany*.

That the ſame matter may cauſe divers diſeaſes.

And the ſame medicine cure them.

AND to aſſiſt you in this inquiry, I ſhall addreſs you to the rare obſervations of the famous and experienced *Henricus ab Heer*, and to his *Spadacrene*; in the eighth chapter of which, he reckons among the diſeaſes, which thoſe waters cure, catarrhs, and the diſtempers, which (according to him) ſpring from thence; as the palſy, trembling of the joints, and other diſeaſes of kin to theſe, convulſions, cephalalgiæ, (I name them in the order, where I find them ſet down) hemicraniæ, vertigo, redneſs of the eyes, of

An inſtance in the waters of the Spaw.

of the face, the eryſipelata, ructus continui, vomitus, ſingultus, obſtructions, and even ſcirrhuſes, if not inveterate, of the liver and ſpleen, and the diſeaſes ſpringing thence; the yellow jaundice, *melancholia flatulenta ſeu hypocondriaca*, dropſies, gravel, ulcers of the kidneys, and carunculæ *in meatu urinario*, gonorrhœas, and reſembling affections, elephantiaſis or the leproſy, *fluor albus mulierum*, cancers and ſcirrhuſes of the womb, fluxes and even dyſenteries; the worms (though very obſtinate, and ſometimes ſo copious as to be voided in his preſence, even with the urine) ſterility, and not only the ſcabies in the body and neck of the bladder, and clammy pituitous matter collected therein, beſides ulcers in the ſphincter of it: but he relates, upon the repeated teſtimony of an eminent perſon, that he names, and one whom he ſtyles *vir omni fide digniſſimus*, that this party being troubled with a very great ſtone in his bladder, and having had it ſearched by divers lithotomiſts, before he came to the *Spaw*, did, by very copiouſly drinking theſe waters, find, by a ſecond ſearch made by thoſe artiſts, that this ſtone was much diminiſhed the firſt year, and (by the ſame way of trial) that it was ſo the ſecond year. And of the cures of theſe diſeaſes, the phyſician mentions in the ſame chapter, as to many of them, particular and remarkable inſtances; and in the beginning of the next chapter, having told his readers, that he expects they ſhould ſcarce believe theſe waters can have ſuch a variety of virtues, *Cæterum*, ſays he, *ſi in Spaa maturè & conſtantibus naturalibus, vitalibuſque facultatibus venerint*; *aquaſque quo dicemus modo biberint, indubitè quæ dixi vera eſſe fatebuntur.* And though we be not bound to believe (nor doth he affirm it) that the *Spaw*-waters do univerſally cure all the afore-mentioned diſtempers; yet it is very much, and makes much for our preſent purpoſe, that they ſhould in ſo many patients cure moſt of theſe diſtempers, and leſſen, if not cure, the reſt. And we may ſomewhat the better credit him, becauſe even where he reckons us the virtues of the *Spaw*, he denies it ſome, which other phyſicians aſcribe to it. And it is very conſiderable, what he ſubjoins in theſe words: *Pauciſſimos enim vel nullos Spadæ incolas capitis doloribus, cardialgiâ, calculo, obſtructionibus renum, hepatis, lienis, meſaraicarum, laborantes invenies*; *ictericos, hydropicos, podagricos, ſcabioſos, epilepticos, quod ſciam, nullos*: ‘You will find very ‘few of thoſe, who dwell at the *Spaw*, who are troubled with the head-ach, ſtone, ‘obſtructions of the kidneys, liver, ſpleen, or meſaraick veins; none at all, who ‘were troubled with the jaundice, dropſy, gout, itch, or falling-ſickneſs.’ But that, which I moſt deſire you to take notice of, is, that beſides all the above-mentioned diſeaſes, I find, that he aſcribes to theſe waters the virtues of curing ſuch, as are counted of a contrary nature, and are thought to require contrary remedies. For beſides that, he expreſly affirms, in the beginning of the eighth chapter, that theſe waters being endowed with the virtues both of hot and cold minerals, they cure both hot and cold affections, in the ſame patients, and in differing bodies; and that contrary effects are performed by them; he hath, after ſome pages, this paſſage, which may go for an illuſtrious proof of that he hath aſſerted: *Inter cætera* (ſaith he, ſpeaking of the *Spaw*-waters) *menſibus movendis in primis idonea, quod millies experientia comprobavit: et tamen nimium eorum fluxum quovis alio medicamento felicius ſiſtit.* ‘Among other qualities, it moved the monthly evacuations, as hath been proved by ‘a thouſand trials: and yet it ſtops the immoderate flux of them more happily than ‘any other medicine.’

THESE teſtimonies, *Pyrophilus*, of our experienced author would perhaps obtain the more credit with you, if you had ſeen what I lately had the opportunity to obſerve in a hot and dry ſeaſon at our own *Tunbridge* waters in *Kent*, when I was there to drink them. And therefore I ſhall again invite you not only to conſider, whether one potent remedy, ſuch as it may be, may not be able to cure variety of diſeaſes, and ſome ſuppoſed to be of contrary natures; but whether or no divers perſons, on whom the received *methodus medendi* hath been long and fruitleſly employed, be not by their tired and deſpondent phyſicians themſelves ſent thither, and there cured of their abſtruſe and obſtinate diſeaſes, by remedies prepared by nature without the aſſiſtance of art: for if you duly reflect on this conſpicuous obſervation, and conſider, how much it is poſſible for art to meliorate and improve moſt (eſpecially mineral) remedies, afforded us by nature, you would probably dare to hope, that medicines might be prepared of greater efficacy, and applicable to more diſeaſes, than they, who think the more received theory of diſeaſes (from which yet very eminent phyſicians, in divers particulars, ſcruple not to recede) incapable of being rectified; and that judge of all remedies by them, that are publickly venal in apothecaries ſhops, will allow themſelves ſo much as to hope.

Of the reaſon and deſign of the author's diſcourſe concerning the Methodus medendi, and his deſcending to other particulars, which may be thought improper for him.

IF now you demand, *Pyrophilus*, If I think that every particular, which hath contributed to ſwell this diſcourſe into a bulk ſo diſproportionate to that, which the title of an eſſay promiſed, to directly belong to the art of phyſick? I ſhall leave it to the judicious *Celſus* (whom learned men have ſtyled the Roman *Hippocrates)* to anſwer for me, and he will tell you, that *quanquam multa ſint ad ipſas artes non pertinentia, tamen eas adjuvant excitando artificis ingenium.* I ſuppoſe I need not remind you, *Pyrophilus*, that it was not my deſign, in what hath been repreſented, to ſubvert thoſe principles of the *methodus medendi*, from which no ſober phyſicians themſelves recede, and in which they unanimouſly acquieſce; and that I much leſs intend to countenance thoſe venturous empiricks, who, without any competent knowledge of anatomy, botanicks, and the hiſtory of diſeaſes, think receipts or proceſſes alone can enable them to cure the ſickneſſes they know not, and who would perſuade men to lay by, as needleſs, a profeſſion, of whoſe uſefulneſs to mankind, we may elſewhere have occaſion to diſcourſe. No, *Pyrophilus*, without peremptorily aſſerting any thing, I have but barely repreſented the notions I have mentioned concerning the *methodus medendi*, as things probable enough to deſerve to be impartially conſidered; that in caſe they prove fit to be declined, they may appear to have been rejected, not by our ſuperciliouſneſs or lazineſs, but (after a fair trial) by our experience: and in caſe they ſeem fit to be approved, they may prove additional inſtances of the uſefulneſs of natural philoſophy to phyſick. Which uſefulneſs, *Pyrophilus*, if I have in any conſiderable meaſure been ſo happy as to make out, I ſhall not think the time (and much leſs the pains) I have beſtowed upon that theme, miſpent. For, I muſt confeſs to you, *Pyrophilus*, that to me it ſeems, that few things ought more to endear to us the ſtudy of natural philoſophy, than that (according to the judicious ſentence of our *Celſus*, *Rerum naturæ contemplatio*, ſaith he, *quamvis non faciat medicum, aptiorem tamen medicinæ reddit:)* 'The contemplation of nature, though it maketh not a phyſician, yet it fits him to learn phyſick:' A deeper inſight into nature may enable men to apply the phyſiological diſcoveries made by it (though ſome more immediately, and ſome leſs directly) to the advancement and improvement of phyſick.

AND I well enough know, *Pyrophilus*, that inſtead of writing the eſſay to ſuch a one as you, if I ſhould write it to the more critical and ſeverer ſort of readers, they would be apt to think, both that it is impertinent for me, who do not profeſs to be a phyſician, to treat prolixly of matters medicinal; and that it may appear ſomewhat below me, in a book, whoſe title ſeems to promiſe you philoſophical matters, to inſert I know not how many receipts. But I ſhall not ſcruple to tell ſuch a perſon as *Pyrophilus*, that ſince my method required, that I ſhould ſay ſomething to you of the therapeutical part of phyſick, I thought, that Chriſtianity and humanity it ſelf obliged me not to conceal thoſe things, which, how deſpicable ſoever they may ſeem to a ſpeculative philoſopher, are yet ſuch, as, beſides that ſome of them may perhaps afford improveable hints touching the nature of remedies, if not alſo of diſeaſes, experience hath encouraged me to hope, that others may prove uſeful to the ſick. And as for the inſerting of receipts, even in books of philoſophical ſubjects, I have not done it altogether without example. For not only *Pliny*, a perſon of a great dignity as well as parts, and friend to one of the greateſt Roman emperors, hath left us in a book, where he handles many philoſophical matters, ſtore of particular receipts; but our chancellor, the Lord *Verulam*, hath not diſdained to record ſome. And as to that induſtrious benefactor to experimental knowledge, the learned and pious *Merſennus*, his charity made him much more fearful to neglect the doing what good he could to others, than to venture to leſſen his reputation by an *indecorum*, that in a mathematical book, and in a chapter of arithmetical combinations, he brings in not only a remedy againſt the eryſipelas, but even a medicine for corns, where he tells us, that they may be taken away, by applying and daily renewing for ten days, or a fortnight, the middle ſtalk, that grows between the blade and the root (for that I ſuppoſe he means by the unuſual word *thallum*) of garlick, bruiſed. Nor is it without examples, though ſomewhat contrary to my cuſtom in my other writings, that in this, and the four precedent eſſays, I have frequently enough alledged the teſtimonies of others, and divers times ſet down proceſſes or receipts, not of my own deviſing. For even among profeſſed and learned phyſicians, ſcarce any thing is more common, than on ſubjects far leſs of kin to paradoxes, than moſt of thoſe I have been diſcourſing of, to make uſe of the teſtimonies and obſervations of other approved writers, to confirm what they teach. And not now to mention the voluminous books of *Schenkius Scolzius*, that famous and experienced practitioner *Riverius* himſelf hath not been aſhamed to publiſh together a good number of receipts, given him by others, under the very title of *Obſervationes communicatæ*: and *Henricus ab Heer* hath, among his *Obſervationes oppido raræ*, divers receipts, that came from mountebanks, and even gypſies. And therefore I hope, that you, who know, that it is not after every body, that I would ſo much as relate an obſervation, or mention a medicine, as thinking them probable, will eaſily excuſe one, that hath much fewer opportunities, than a profeſſed phyſician, to try remedies himſelf; if treating of ſubjects not ſo familiar, I chooſe to countenance what I deliver by the teſtimonies of ſkilful men, and if I ſcruple not to preſerve in theſe papers ſome not deſpicable remedies, as well of abler men, as of my own, that otherwiſe would probably be loſt. But of this practice I may elſewhere have occaſion to give you a more full apology, by ſhewing, how much it may conduce to the enriching and advancement of phyſick; an art, with whoſe praiſes I could long entertain you, if I were at leiſure (and durſt allow my ſelf) to exhauſt common places.

AND yet give me leave to tell you, that man is ſo noble a creature, and his health ſo requiſite to his being able to reliſh other goods; and oftentimes alſo to the comfortable performance of what his conſcience, his country, his family, his neceſſities, and perhaps his allowable curioſity challenge from him, that I wonder not ſo much at thoſe antient heathens, that, being polytheiſts and idolaters, thought themſelves obliged, either to refer ſo uſeful an art, as that of phyſick, to the gods, or godlike perſons; or to add thoſe, that excelled in ſo noble a faculty, to the number of thoſe they worſhipped. For my part, *Pyrophilus*, a very tender and ſickly conſtitution of my own (much impaired by ſuch unhappy accidents as falls, bruiſes, *&c.*) hath, beſides (as I hope) better motives of compaſſion, given me ſo great a ſenſe of the uneaſineſſes, that are wont to attend ſickneſs, that I confeſs, if I ſtudy chymiſtry, it is very much out of hope, that it may be uſefully imployed againſt ſtubborn diſeaſes, and relieve ſome languiſhing patients with leſs pain and trouble, than otherwiſe they are like to undergo for recovery. And really, *Pyrophilus*, unleſs we will too groſly flatter our ſelves, we can ſcarce avoid both diſcerning and deploring the ineffectualneſs of our vulgar medicines, not only Galenical, but chymical, (for an active body may yet be but a languid remedy). For beſides that many, that recover upon the uſe of them, endure more for health, than many, that are juſtly reckoned among martyrs, did for religion; beſides this, I ſay, we daily meet with but too many in the caſe of that bleeding woman, mentioned in the Goſpel, of whom it is ſaid, that ſhe had ſuffered many things of many phyſicians, and had ſpent all that ſhe had, and was nothing bettered, but rather grew worſe. And therefore I reckon the inveſtigation and divulging of uſeful truths in phyſick, and the diſcovering and recommending of good remedies, among the greateſt and moſt extenſive acts of charity, and ſuch, as by which a man may really more oblige mankind, and relieve more diſtreſſed perſons, than if he built an hoſpital. Which perhaps you will not think raſhly ſaid, if you pleaſe but to conſider, how many the knowledge of the ſalivating, and other active properties of mercury, and of its enmity to putrefaction and diſtempers ſpringing thence, have cured of ſeveral diſeaſes; and conſequently how many more patients, than have recovered in the greateſt hoſpital in the world, are obliged to *Carpus*, and thoſe others, whoever they were, that were the firſt diſcoverers of the medical efficacy of quickſilver. And for my own particular, *Pyrophilus*, though my youth and condition forbid me the practice of phyſick, and though my unhappy conſtitution of body kept divers remedies from doing me the ſame good they are wont to do others; yet having more than once prepared, and ſometimes occaſionally had opportunity to adminiſter medicines, which God hath been ſo far pleaſed to bleſs on others, as to make them relieve ſeveral patients, and ſeem (at leaſt) to have ſnatched ſome of them almoſt out of the jaws of death; I eſteem my ſelf, by thoſe ſucceſſes alone, ſufficiently recompenſed, for any toil and charge my inquiries into nature may have coſt me. And though I ignore not, that it is a much more faſhionable and celebrated practice in young gentlemen, to kill men, than to cure them; and that miſtaken mortals think it the nobleſt exerciſe of virtue to deſtroy the nobleſt workmanſhip of nature, (and indeed in ſome few caſes the requiſiteneſs and danger of deſtructive valour may make its actions become a virtuous patriot) yet when I conſider the character given of our great maſter and exemplar, in that ſcripture, which ſays, *That he went about doing good, and healing all manner of ſickneſs, and all manner of diſeaſes among the people*; I cannot but think ſuch an imployment worthy of the very nobleſt of his diſciples. And I confeſs, that if it were allowed me to envy creatures ſo much above us as are the celeſtial ſpirits, I ſhould much more envy that welcome angel's charitable imployment, who at ſet times diffuſed a healing virtue, through the troubled waters of *Betheſda*, than that dreadful angel's fatal imployment, who in one night deſtroyed above a hundred and fourſcore thouſand fighting men. But of the deſireableneſs of the ſkill, and willingneſs to cure the ſick, and relieve not only thoſe, that languiſh in hoſpitals, but thoſe that are rich enough to build them, having elſewhere purpoſely diſcourſed, I muſt now trouble you no longer on this theme, but implore your much-needed pardon, for my having been (beyond my firſt intentions) ſo troubleſome to you already.

Mark v. 26.

That this employment is better than the more faſhionable of deſtroying valour.

Acts x. 38.
Mat. iv. 24.

Joh. v. 14.
2 Kings xix. 35.

The angel's charitable employment at Betheſda more deſireable than his, who deſtroyed in one night 180,000 fighting men.

# AN APPENDIX TO THE FIRST SECTION of the SECOND PART.

## *Advertiſements touching the following* APPENDIX.

I SCARCE doubt, but it will be expected, that I ſhould annex to the foregoing treatiſe thoſe receipts and proceſſes, which ſeem to be here and there promiſed in it: But I deſire it may be conſidered, that ſome paſſages, which an unattentive reader may have miſtaken for abſolute promiſes, are indeed but profers conditionally made to a particular perſon; and ſo not engaging me, till the condition (which was his deſiring the thing mentioned to him) be on his part performed. And as for the other things, which every reader may ſuppoſe to be promiſed him, I have at hand this general excuſe; that at leaſt I promiſed nothing to the publick, whatever promiſes I may have made in the foregoing Eſſays, having together with them been addreſſed to a private friend. And I have two or three ſpecial reaſons to inſiſt on this excuſe; for divers of my choicer books and papers having not long ſince unhappily miſcarried through the negligence of ſome men, and fraud of others, it is not now poſſible for me to retrieve ſome of the things I was maſter of, when I promiſed them. And then to reviſe carefully all the papers, that remain in my hands, of affinity with the paſt treatiſes, would take up more time, than is allowed me by other ſtudies and employments, which I think of greater moment, or at leaſt wherein I am much more concerned, than to give this book at preſent a full or accurate Appendix.

But though I might, upon theſe and other reaſons, wholly excuſe my ſelf from the trouble of adding any appendix; yet becauſe the communicating of good medicines is a work of charity, and thoſe unpoliſhed and immethodical notes, that may perchance diſparage an author, may yet relieve many a patient; I am willing to do what my occaſion will permit: and finding among my papers many looſe ſheets, concerning ſpirit of harts-horn, blood, &c. written divers years ſince to a friend, I chuſe rather to publiſh them juſt as I find them with *Pyrophilus*'s name, employed in convenient places, and to add ſome unpromiſed receipts in ſtead of thoſe, that are loſt, than be altogether wanting to what may be expected from me. I know, that what I deliver concerning ſome of the following preparations, may by ſeverer criticks be thought ſomewhat unaccurate, and I confeſs I am of that mind my ſelf; but meeting with theſe collections in looſe ſheets among my old papers, I muſt either publiſh them as I find them, or take the pains to poliſh and contract them; which would require more time, than I can at preſent afford them. And much leſs can I ſtay to ſubjoin the hiſtories of the particular cures performed by the medicines, whoſe preparations I ſet down, though divers of them would not perhaps appear inconſiderable. But if I find by the entertainment of theſe papers, that it will be worth while to reviſe or enlarge them, I may, God permitting, be invited to do it, and either ſupply the things, that are here deficient, out of after obſervations, or papers now out of the way, or make amends for their omiſſion in ſubſtituting better things.

It will not at all ſurprize me, if ſome readers think me too prolix in delivering the preparations of harts-horn, ens Veneris, *&c.* with ſuch particular and circumſtantial obſervations. But my deſign being to gratify and aſſiſt thoſe that would make and uſe the remedies I recommend, the experience I have had of the difficulties moſt men find in the preparing things by the direction of chymical proceſſes not very expreſly ſet down, makes me apt to hope, that (I ſay not the great phyſicians or chymiſts, who may, if they pleaſe, leave them unperuſed; but) thoſe for whom I principally intend my directions, will think my having made them ſo particular a very excuſable fault. And I make the leſs difficulty to ſuffer ſuch things, as perhaps I judge to be, in compariſon of others, but trifles, to paſs abroad; becauſe finding of late years, that many perſons of quality of either ſex, who ſcarce read any other than Engliſh books, have (as I hope) out of charity, or curioſity, or both, begun to addict themſelves to chymiſtry, and venture to be tampering with ſpagyrical remedies; it may not be unſeaſonable to ſupply them with ſome preparations, that may both ſave them time and charges, and put them upon the uſe of remedies, which, without being languid, are, if any thing diſcreetly given, ſafe and innocent, and wherein a little error either in the making or the adminiſtring will be far leſs prejudicial to the ſick, than if it were committed in the more vulgar (oftentimes, either falſly or obſcurely preſcribed) preparations they are wont to make of acid ſalts, mercury, antimony, and other minerals; whoſe activity for the moſt part makes them need to be ſkilfully prepared and judiciouſly given.

### To the 96th Page.

### The Iriſh lithotomiſt's receipt, for the ſtone in the bladder.

REC. *Aquar. melon. citrullor. filipendulæ, petroſelin. ſyr. è* 5 *radicibus, ſyr. de Byſantiis, ana unc.* ij. *oxymelit. comp. unc.* j. *miſce; quartam mixti partem ſumas manè jejunus, & poſtea per octo horas à cibo & potu abſtineas, aliam ſumas partem eodem die poſt cœnam cum lectum intrare volueris. Denique ſequenti die reliquæ ſumantur partis ut primæ; tertio verò die,*

Rec. *Elect. lenit. drachm.* iij. *ſyr. roſat. ſolut. drachm.* ij. *pulp. tamarind. drachm.* j. *miſceantur ac in ſeri lactis unc.* iij. *diſſolvantur: totum bibas mane quatuor horis ante jus, quarto die ſumas mane ſequentis pulv. drachm.* j. *mixti inſequentis apozematis unc.* iiij. *& olei amygd. dulc. unc. ſem.*

Rec. *Cinerum vitri, & ſcorpionum pulveris lapid. ſpongiæ, & lap. Judaici, acori, ſem. altheæ, millii ſolis, ſaxifragii ana drachm.* j. *ſem. lactucæ,* 4 *ſem. frigid. majorum ana drachm. ſem. trochiſcor. alkekengi, rad. pimpinellæ ana drachm.* ij. *fiat pulvis ſubtilis.*

Apozema.

Rec. *Parietariæ, rad. alth. ana* m.j. *ſem. petroſelini, glycyrrhiza ana unc. ſem. halicacabi unc.* j. *coq. in aq. pluviæ ſext.* 2. *& vini albiſſimi ſext.* j. *ad medietatis conſumptionem, & colatura melle hybernico dulceretur.*

*Tum quarto illo die paſſerculum trogloditem ſale antea conditum edas una cum cœna, et poſt cœnam lumbi, pubes, & tota renum regio oleis è granis citri & ſcorpion. liniantur, etſi poſſibile eſſet prædicta olea per meatum urinar. in veſicam injiciantur, ſitque dein è pulvere, apozemate, troglodite & oleis omni die utere, donec arenulæ aut lap. fragmenta una cum expulſis apparuerint.*

*Loco cinerum vitri ſumi poſſunt cineres camini & vires cinerum ſcorpionum ſupplere poteſt pulvis lumbricor. terreſtr. probè in vino lotorum & poſtea exſiccatorum.*

*N. B.* [As far as I could conjecture by the diſcourſe I had with the owner of the receipt, by aſhes of glaſs he means the ſuperfluous ſaline ſubſtance, which the glaſs-men are wont to call *Sandiver*; but becauſe he did not explain himſelf ſo clearly, and we know not yet a way of burning glaſs to aſhes, I think it will be moſt adviſeable to ſubſtitute the wood-aſhes, which in the receipt it ſelf towards the cloſe of it are appointed for a ſuccedaneum.]

### To the 115th Page.

[*Where the Virtues of the* Pilulæ Lunares *are touched at.*]

THE great benefit, that has redounded to many patients, from the uſe of the ſilver pills, here briefly mentioned, and commended, invites me to communicate, as a conſiderable thing, the preparation of them, of which I do not pretend to be the inventor; having, divers years ſince, learned it by diſcourſing with a very ancient and experienced chymiſt, whoſe name, that I do not mention, will perhaps ſeem ſomewhat ſtrange to thoſe readers, that have obſerved me not to be backward in acknowledging my benefactors in point of experiments; and therefore I hold it not amiſs to take this opportunity of declaring once for all, that it were oftentimes more prejudicial than grateful to one, that makes an advantage by the practiſe of phyſick, to annex in his life-time his name to ſome of his receipts or proceſſes; becauſe that when a man has once got a repute for having a ſpecifick in any particular diſeaſe or caſe, his patients and their friends will hardly forbear to apply themſelves to him for that medicine, though the ſame medicine, but not known to be the ſame, ſhould be made uſe of by a ſtranger, or divulged in a printed book; moſt patients being not apt to rely upon medicines, that come only that way recommended; whereas if it were known, that the printed receipt is the ſelf-ſame, which the phyſician employs, not only other phyſicians would quickly make as much advantage of it as he, but many patients would think themſelves by that diſcovery diſpenſed with, in point of good huſbandry, from going to any phyſician at all, as knowing beforehand the beſt preſcription they are like to receive from him: The proceſs of the *Pilulæ lunares* is this:

**The preparation of the Pilulæ lunares.**

TAKE of the beſt refined ſilver as much as you pleaſe, diſſolve it into a ſufficient quantity of cleanſed ſpirit of nitre, or aqua fortis; then evaporating away the ſuperfluous moiſture, let the reſt ſhoot into thin cryſtals: theſe you may in ſome open-mouthed glaſs place in ſand, and keep in ſuch a degree of heat, that by the help of very frequently ſtirring them, the greateſt part of the more looſe and ſtinking ſpirits of the menſtruum may be driven away, and yet the remaining cryſtals not be brought to flow: theſe cryſtals of ſilver you muſt counterpoiſe with an equal weight of cryſtals of nitre; and firſt diſſolving each of them apart in diſtilled rain-water, you muſt afterwards mingle the ſolutions, and abſtract or ſteam away the ſuperfluous moiſture, till the remaining maſs be dry; which you muſt keep in an open glaſs, expoſed to ſuch a temperate heat of ſand, that the matter may not melt (which you muſt be very careful of) and that yet the adhering corroſive ſpirits of the menſtruum might be driven away. And to both theſe ends you muſt from time to time ſtir the maſs, that new parts of it may be expoſed to the heat, and new ones to the air, till you cannot deſcry in the remaining white powder any offenſive ſcent of the ſpirit of nitre, or of the aqua fortis. And laſtly, you muſt take the crumb of good white bread, made with a little moiſture into a ſtiff paſte, and exactly mingle with the newly mentioned magiſtery or powder as much of this paſte, as is neceſſary to give it the conſiſtence of a maſs of pills, which you may thence form at pleaſure, and preſerve in a well-ſtopped glaſs for uſe.

*N. B.* FIRST,

*N. B.* First, the ſilver employed in this operation ought to be very pure and more exquiſitely refined, than much of that is wont to be, which here in *England* is bought for fine ſilver; for if the copper, wherewith ſilver-coins are wont to be alloyed, be not carefully ſeparated upon the cupel, it may, being turned by the acid menſtruum into a kind of vitriol, when it is taken into the body, either provoke vomits, or otherwiſe diſcompoſe it.

Secondly, the ſpirit of nitre, or (which in our caſe comes almoſt to one) the aqua fortis, that is uſed about this medicine, ought to be cleared, as our refiners phraſe it, before the ſilver be put in; for (as I elſewhere note) in ſalt-petre there is oftentimes an undiſcerned mixture of ſea-ſalt, whoſe ſpirit coming over in diſtillation with that of nitre, is apt to precipitate the ſilver, which the ſpirit of nitre has diſſolved. This I take to be the reaſon of that practice of the beſt refiners to purify their aqua fortis, by caſting in ſome ſmall piece of ſilver, that they may afterwards ſecurely put into it greater quantities of the ſame metal to be diſſolved. For the ſaline ſpirits fall to the bottom, together with the corroded ſilver, which they precipitate as long as there is any of theſe ſaline ſpirits left in the menſtruum, which after this may be decanted clear; and though you had put a little more ſilver than needed to it, it neither does harm nor is loſt, the aqua fortis preſerving none unprecipitated, but what there were no more ſaline ſpirits to work upon; ſo that the ſuperfluous ſilver put in is already diſſolved to your hand.

Thirdly, the dry mixture obtained from the ſolutions of cryſtals of nitre, and cryſtals of ſilver, muſt be often ſtirred and kept longer in the ſand, before all the offenſive ſpirits will be driven away, than, till experience had informed me, I did imagine.

Fourthly, if the cryſtals of ſilver be conſiderably blue or green, it is a ſign the ſilver was not ſufficiently purged from copper; elſe the mixture we have been ſpeaking of, will look of a white, good enough. And poſſibly it was by reaſon of the not being careful to take ſufficiently refined ſilver, and of the not knowing how to improve the cryſtals of ſilver, by the addition of thoſe of nitre, and eſpecially how to free them from the ſtinking and corroſive ſpirits of aqua fortis, that it is come to paſs, that though there being ſome chymical writers proceſſes not very unlike this, yet the cryſtals of ſilver have been cenſured and laid aſide, as not always ſafe, even by thoſe, who otherwiſe much magnify the efficacy of thoſe they uſed.

Fifthly, when you are about to make up this mixture with the crumb of bread into a maſs, and ſo into pills, it will not be amiſs to diſpatch that work at once; for uſually it leaves an ugly blackneſs on the fingers, that cannot under divers days be gotten off.

The doſe and uſe of theſe pills.

Sixthly, in taking of the pills care muſt be had, that they be ſufficiently lapped up either in a wafer wetted with milk, or the pulp of a roaſted apple, or ſome ſuch thing, that they may not touch the palate, or the throat, becauſe of the extreme and diſguſting bitterneſs, which is to be met with in the cryſtals of ſilver, and which is not the leaſt thing, that with nicer perſons does blemiſh theſe pills.

Seventhly, the doſe is ſomewhat uncertain; becauſe they work much according to the conſtitution of the body, and eſpecially according as it abounds with ſerous humours: wherefore it is adviſeable to make the pills of the ſize of very ſmall peas, of which one given at bed-time is a ſufficient doſe for ſome bodies, others will require two; and in ſome, we muſt aſcend to three: and if the patient be hydropical, or be otherwiſe much moleſted with ſerous humours, it is obſervable, that ſometimes one doſe will work two days, or four days, (may be five or ſix) ſucceſſively,

ſively, but yet moderately and uſually, without weakening the patient, in proportion to ſuch copious evacuations.

Eighthly, Beſides the dropſy, wherein we have mentioned this remedy as a ſpecifick, it often proves very available in other caſes, wherein men are troubled with ſerous humours. But the firſt diſtempers, which I heard it magnified for, were thoſe of the head, and *Genus nervoſum*; and a great virtuoſo of my acquaintance, that inherits a diſpoſition to the palſy, has ſeveral times told me, that if when he begins to find himſelf diſordered, he takes a doſe of theſe pills, he is thereby conſtantly relieved. But of the particular caſes, wherein we have had opportunity to take notice of their effects, we have not now, but may perchance another time, have leiſure to entertain you.

Lastly, That ſkilful and ſucceſsful chymiſt Dr. *N. N.* who doth much both uſe and eſteem this remedy, being deſired by me to let me know, if he had any objections againſt it, informs me, that when he hath given theſe pills oftentimes, and without intervals, though they did not either ſalivate or vomit, or much weaken the patient, yet they would at laſt be attended with a kind of incipient leucophlegmatia, which he eaſily prevents by intermitting for a while the uſe of the pills, after every ſecond or third time, that he adminiſters them, and giving, when he expects it to be requiſite, ſome *Crocus Martis*, extract of juniper, or other aſtringent or hepatick medicines, to corroborate the viſcera, and preſerve their tone.

### To the 116th Page.

*(Where mention is made of the cure of one, concluded to have a gangrene, by an inward medicine.)*

THE cure mentioned in this place having been performed by that medicine, which from the name of that great commander as well as virtuoſo, who was the author of it, paſſes under the name of Sir *Walter Raleigh*'s cordial, and this being but one of many remarkable (and ſome of them ſtupendous) cures, which have been wrought by it from time to time, eſpecially of late, that it hath been more uſed, I am induced to annex here the yet unpubliſhed receipt; partly, becauſe there are divers receipts, that are each pretended to be the true, magnified by their ſeveral poſſeſſors; and I had the liberty of looking it out in a receipt-book, preſerved by the author's ſon; and partly becauſe, though I will not affirm, that a ſkilfuller or more promiſing compoſition of the ſame ingredients could not have been deviſed, yet the following receipt has been abundantly recommended by experience. And I remember, that but a while ſince a perſon of note having ſent to me, to deſire a taking of this cordial for a certain knight, who after all that ſkilful phyſicians could do, had long lain a dying; I the other day chanced to meet this knight at *White Hall*, well, lively, and with a face, whoſe ruddineſs argued a perfect recovery, and yet he is not very far from ſeventy years of age, and had, before he grew ſo ill, long conflicted with a tedious ague, and fever, which had reduced him to that extremity, when the cordial was brought, that, as himſelf told me, he neither was ſenſible, when they gave it him, nor had known what he did, or what was done unto him, during the ſpace of ſeveral days before.

### *Sir* Walter Raleigh's *cordial, after Sir* R. K. *his way,* (*ſet down* verbatim, *as I the author received it.*)

TAKE burrage-flowers, roſemary-flowers, marigold-flowers, red july-flowers, roſa-ſolis, elder-flowers, of each one pottle; after they are dried in the ſhade.

TAKE alſo of ſcordium, carduus, angelica, balm, mint, marjoram, ſetwall, betony, *ana* four handfuls, after they are dried in the ſhade.

TAKE alſo of the rinds of ſaſſafras of *Virginia*, lignum aloes, *ana* four ounces beaten to powder; of kermes, cubebs, cardamoms, zedoary, *ana* one ounce; of ſaffron half an ounce; juniper-berries, tormentil-roots, round birthwort roots, of each one ounce; of gentian-roots half an ounce.

DRAW the tincture or extract of theſe with ſpirit of wine in *balneo*, and ſave all the ingredients, after you have taken out the tinctures, and burn them, and put their ſalt into their tinctures.

TAKE ſix ounces of the extracts of all theſe with their ſalt, and put thereto of the tincture of coral three ounces; terra ſigillata four ounces; pearl prepared two ounces; bezoar-ſtone three drachms, hartſhorn calcined four ounces, ambergreaſe four drachms, muſk *gr.* xxx; ſugar-candy one pound and an half, ground very fine, and ſearſed through a fine ſearſe.

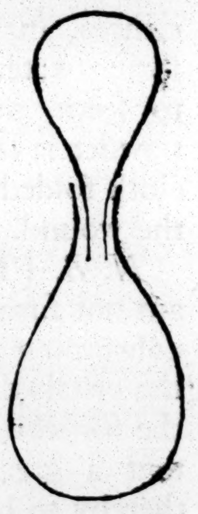
THEN the muſk and amber muſt be ground, and by little and little mingled with it; the more you grind the amber, the better.

THEN put to the ſugar-candy all the dry materials before directed, and make all as ſmall as poſſibly you can.

THEN upon a great hollow grinding-ſtone mingle the tinctures, and dry things together; (which muſt be done by a ſtrong man uſed to that work:) and whilſt it is in grinding, put of ſyrup of lemons, and ſyrup of red roſes equal parts into it, elſe it will be ſo dry, that it will neither grind nor mingle.

### *How to make the tincture of Coral for this Cardial.*

TAKE eight ounces of coral, and put it unbeaten into a calcining pot unluted, and let it ſtand twenty four hours in a calcining or glaſs-furnace, till the coral be as white as ſnow; then put it in three quarters of diſtilled vinegar in a long glaſs with a narrow mouth, and with another ſmall glaſs or phial put into the mouth of it, the belly upwards, to ſave the vinegar from waſting, thus: and ſet in a ſand-furnace, ſo as the ſand may be as high as the vinegar.



LET it boil without intermiſſion twenty-four hours, by which time the vinegar will become red; ſo, when it is cold, pour off the vinegar into a glaſs-baſon, or a bell-glaſs, and vapour away all the vinegar in *balneo*, and gather the coral, being perfectly dry, for your uſe. You may ſtrike down your pearl with oil of vitriol, and oil of ſulphur, equal parts, which is accounted the beſt way to prepare the pearl: but Sir *R. K.* did uſe to prepare his pearl by juice of lemons.

[THE doſe for a man is about the bigneſs of a ſmall hazel-nut; but where prevention is only aimed at, or ſome ſuch uſe as the diſſipating the fumes of the ſpleen, as they call it, the bigneſs of an ordinary pea may ſuffice; ſo in urgent caſes the doſe may be increaſed to the quantity of a nutmeg. It is uſually given by it ſelf upon an empty ſtomach (the patient being kept warm after it, to promote ſweat) in fevers, want of ſpirits, violent fluxes, and ſeveral other diſtempers, where diaphoreticks, and antidotes are proper, and (eſpecially) potent cordials are required.

### [To the 116th Page, Where a receipt that cured fiſtulas is mentioned.]

*A water for a fiſtula, and all manner of wounds and ſwellings, or old ulcers, cankers, tetters, boils, or ſcabs in any place, or green wounds.*

TAKE of bole-armoniack four ounces, of camphire one ounce, of white vitriol four ounces; boil the camphire and the vitriol together in a little black earthen pot, till they become thin, ſtirring them together, till they become hard in ſettling; then bruiſe them in a mortar to powder, and beat the bole-armoniack it ſelf to powder, and then mingle them together, and keep the powder in a bladder, till ſuch time you uſe it. Then take a pottle of running water, and ſet it on the fire, till it begin to ſeeth; then take it from the fire, and put in three good ſpoonfuls of the powder into the water whilſt it is hot, and after put the water and powder into a glaſs, and ſhake it twice a day, to make the water ſtrong: but before you uſe it, let it be well ſettled and very clear, and apply it as hot as the patient can well ſuffer it; and lay a clean linnen cloth, four double, to the ſore, it being wet in that water, and bind it faſt with a roller to keep it warm; do it morning and evening, till it be whole. This water muſt be put into an oyſter-ſhell, not in a ſaucer, when you dreſs the ſore, for the pewter will ſuck it up. Remember you put three as good ſpoonfuls of powder as you can preſs into the ſpoon. Take heed no one drink of this water, for it is poiſon. To make it ſtronger, beat an ounce of alum to powder, and mingle it with the other powders.

TAKE of bole-armoniack half an ounce, white vitriol one ounce, of camphire two ounces, make them all into powder; then take a pottle of ſmiths-water, and as much ſpring-water, and mingling them, ſet them upon the fire. As ſoon as it begins to ſeeth, put in the powder very ſoftly, ſtirring it all the while: as ſoon as the powder is in, take it off the fire, and dreſs the wound with it twice a day, laying a cloth folded four times and wetted in the water, it being very hot, and ſo applied to the wound.

*N. B.* [THIS is the receipt *verbatim*, as I find it among my old papers, but I am not ſure, that among thoſe I cannot now come by, there may not be ſomething concerning a way of making a ſmall pliable tent, that may accommodate it ſelf to the crooked figure of the cavity of many fiſtulas. For methinks I remember, that the ſurgeon preſcribed the conveying the medicine by the means of ſuch a flexible tent a great way into the cavity, if not to the bottom of the fiſtula, which was thereby to be cleanſed.]

### To the 129th Page. *Where ſoot is mentioned.*

SOOT, *Pyrophilus*, is a production of fire, whoſe nature is almoſt as ſingular, as is the manner of its being produced; for it is (if I may ſo call it) a kind of volatile extract of the wood it proceeds from, made inſtead of a menſtruum by the fire, which haſtily diſſipating the parts of the body it acts on, hath time enough to ſever it into ſmaller particles, but not leiſure and aptitude to reduce it into ſuch differing ſubſtances, as paſs for chymical or peripatetick elements; but haſtily carries up the more volatile parts, which being not yet ſufficiently freed from the more fixed ones, take them up along with them in their ſudden flight, and ſo the aqueous, ſpirituous, ſaline, oleaginous and terreſtrial parts aſcending confuſedly together, do faſten themſelves to the ſides of the chimney in that looſe and irregular form of concretion, which we call ſoot: an inquiry into whoſe nature, as it may be conſidered in the ſurvey of the diſtinction of ſalts, muſt be elſewhere looked for; our mentioning it at preſent being only to take occaſion to tell you, that, as ill-ſcented and deſpiſed a body as it is, *Hartman* (one of the moſt experienced and happy of chymical writers) ſcruples not to reckon the ſpirit and oil of it among the nobleſt *confortantia*; ſuch as prepared pearl, coral, amber-greeſe, and other eminent cheriſhers of nature. His preparation is for ſubſtance this: Take of the beſt ſoot, (ſuch as adheres to the lower part of the chimney, and ſhines almoſt like jet) what quantity you pleaſe, and with it fill up to the neck a very well-coated glaſs retort, or an earthen one, and luting on a capacious receiver, diſtil the matter in an open fire intended by degrees, whereby you will drive over the phlegm, the whitiſh ſpirits, and the oil, firſt of a yellow colour, and then of a red; ſeparate the phlegm, and for a while digeſt the ſpirit and the oil together, on which afterwards put half the quantity of ſpirit of wine, and diſtil them ſeveral times, whereby you will obtain, together with the ſpirit of wine, the ſpirit of ſoot, and alſo a very depurated oil, ſmelling like camphire. Out of the calcined *caput mortuum* after the common way extract a ſalt, which *Hartman* commends as a moſt excellent curer of exulcerated cancers: this ſalt, ſaith he, is drawn with vinegar; in which liquor, in a cold moiſt place, it is again diſſolved; and therewith the cancerous ulcers being once or twice anointed, the venenoſity will be viſibly drawn out like a vapour, and then the fore-mentioned oil being lightly ſprinkled upon the place, will breed on it a kind of cruſt like a ſkin, which ſpontaneouſly coming off in five or ſix days, will, by its falling off, argue the conſolidation of the ulcer. What this ſo extolled remedy will perform, I know not, having never made trial of it, nor thinking it very likely, that a bare alcalizate ſalt ſhould have ſuch ſpecifick virtues; nor is it requiſite I ſhould inſiſt on it, being here to diſcourſe to you of the diſtilled liquors of ſoot; in proſecution of which deſign, let me tell you, that *Hartman* preſcribes the adminiſtring of the ſpirit from ſix to ten grains, of the oil from two or three drops in wine, or any other convenient vehicle: and concerning the oil he adds, that if three drops of it be given in vinegar to an almoſt gaſping man, he will be thereby wonderfully refreſhed, and as it were revived; to which he annexeth this prognoſtick, that if the remedy produceth copious ſweats, it will recover the taker; but if not, he will die.

**Hartman's preparation of ſpirit and oil of ſoot.**

**Hartm. Prax. Chym. p. 12.**

THAT this ſpirit of ſoot, deſcribed by *Hartman*, may be a very good medicine, I am very apt to think; but becauſe it is not a meer ſpirit of ſoot, but a mixed one of ſpirit of wine, and ſpirit of ſoot, we have rather choſen to proceed with the ſoot (of wood) without addition, both as to the diſtillation of it, and the ordering of the diſtilled liquors, after the manners to be mentioned ere long, when we ſhall acquaint you with our preparations of blood and hartſhorn; which if you pleaſe to apply to ſoot, you may ſave your ſelf, and me, the labour of repetitions. Yet it may not be amiſs to advertiſe you here of two things: the one, that if you employ very good and fat ſoot, and fill up the retort with it to the neck, you muſt be very careful to increaſe the fire orderly, and but by moderate degrees; or elſe you may chance to make the matter boil over out of the retort into the receiver; as it lately happened to us, when having warily ordered the fire for ſeveral hours, we thought ourſelves paſt any ſuch danger: and the other, that as to the medicinal virtues of the ſpirit, and ſalt of ſoot, I ſhall not now particularize them; partly that I may ſave time, and partly becauſe they may be well enough gathered from their affinity to the volatile ſalts and ſpirits of animal ſubſtances hereafter to be treated of; and from what I ſhall have occaſion to ſay, of the perfuming of the ſalt ſoot, towards the cloſe of this Appendix.

**The author's directions concerning preparations from ſoot.**

## To the 130th Page.

Of the uſes of the preparations of urine.

URINE is a body, which, as homely and deſpiſed as it is wont to be, may, by ſkilful ways of ordering it, be made either alone, or in conjunction with other ingredients, to afford ſuch a variety of uſeful ſubſtances, that I find *Reuſnerus* publiſhed an entire treatiſe, which yet I never could get ſight of, under the title of *Synopſis remediorum ex urina præparatorum*, beſides what other chymiſts have ſince divulged on the ſame ſubject, which I forbear to mention; becauſe ſeveral of them I have not tried, and many others I think ſcarce worth trying. But becauſe even all our own obſervations, concerning the preparations and uſes of things afforded by urine, would take up more time and room, than I can now allow them, I ſhall here only take this occaſion to intimate thus much in general, that the ſpirit and ſalt of urine may be made far greater uſe of, than men yet are prone to think; not only in phyſick, but in chymiſtry, and perhaps I durſt add in natural philoſophy too. And though *Helmont* be not wont to laviſh his praiſes upon worthleſs remedies, yet he calls it *nobile ad icterum, alioſque morbos, remedium.* And in another place, ſpeaking of the ſaline cryſtals of urine, he hath this expreſſion: *Quæ quanquam ad veteres excrementorum oppilationes conferunt, nihil tamen adverſus lithiaſin*; which ſeems, by denying to the ſalt of urine ſome virtues aſcribed to it by many other chymiſts, to bring ſome credit to his praiſes of it. (And indeed a friend of mine, that has tried it in the jaundice, affirms it to deſerve the commendation he gives it in that diſeaſe.) And though I fear our author hyperbolizeth, where he (elſewhere) thus writes; *ſpernit eos ſapientia* (he means ſure that, which is proper to the Spagyriſts) *qui materiam ex qua diſpoſitiones, contenta, proprietates, progreſſum & ſignificationes lotii addiſcere recuſarent per ignem:* yet perhaps the hyperbole is not altogether ſo extravagant, as moſt readers will think it. And I remember, that a while ago, conferring with a publick miniſter of a foreign prince, who is a very inquiſitive and experienced perſon, he freely told me, that though he had travelled very much, and divers times not in a capacity, yet the greateſt chymiſt, that ever he could make acquaintance with, uſed to tell him, that ſalt of urine was ſo precious a thing, that it was a pity it ſhould be uſed in ordinary diſeaſes: but what his reaſons were for valuing it ſo much, he would not declare, and therefore I ſhall lay no great weight upon his teſtimony. And yet I muſt not at this time particularly declare, upon what account it is, that I do ſo value the volatile ſalt of urine, of whoſe virtues (whilſt it is ſingle) I ſhall only in a word obſerve to you now (what is pertinent to the occaſion of my mentioning it at preſent) namely, that when it is well prepared [*according to the way plainly enough, though but very briefly touched already*] it differs ſo little in ſmell, taſte, volatility, penetrancy, and ſome other manifeſt qualities, from the ſalt of hartſhorn, and that of man's blood; that ſuch effects, though perhaps ſomewhat leſs powerful, may be not improbably expected from it, as are produced by the other.

De Lithiaſt. c. 3. n. 3.

## To the 131ſt Page.

Of the preparations of man's blood.

*Though I have not in this place made any abſolute promiſe, of annexing any thing more particular touching the ſpirit of blood; and though I cannot now find, and I fear may have loſt thoſe of my papers concerning that ſubject, which were the leaſt unaccurate: yet, ſetting aſide former trials, a recent account brought me by a phyſician, whom I had entruſted with ſome of it, repreſents it as ſo very good a medicine, that I am content to ſubjoin, what particulars I have lately found among my looſe papers concerning it, as I many years ago ſent them to a friend; and this I rather do, becauſe there being annexed to the proceſs divers obſervations of general import to ſuch kind of preparations, they will* *be the better underſtood with it, than without it, and I have not now the leiſure to new-mould them.*

Thus then;

TAKE of the blood of an healthy young man, as much as you pleaſe, and whilſt it is yet warm, add to it * twice its weight of good ſpirit of wine, and incorporating them well together, ſhut them carefully up in a convenient glaſs-veſſel, wherein the matter muſt be ſet to digeſt *in balneo*, or horſe-dung, for ſix weeks, or more: then in a glaſs-head and body, placed in aſhes or ſand, draw off with a gentle heat as much liquor, as will come over without neceſſitating you to impreſs any empyreuma upon it; the remaining matter muſt be taken out, and put into a ſtrong and capacious retort, which being placed in ſand, and accommodated with a large receiver carefully luted to it, the matter therein lodged muſt be gradually preſſed with a vehement fire, which muſt at length be increaſed, till it be ſtrong enough to give the bottom of the retort a red heat. There will firſt come over (after perhaps a little phlegm) ſpirit, either accompanied or cloſely followed by a copious volatile ſalt, faſtening it ſelf to the ſides and top of the receiver; and much about the ſame time, there will alſo come over an oil or two, or more, (for I have not obſerved the oleaginous part to come conſtantly and regularly after the ſame manner). The receiver being taken off, all that it contains may be poured together into a convenient phial, to be therein digeſted for a month, if you pleaſe; or otherwiſe without that previous digeſtion, you may waſh down the volatile ſalt adhering to the ſides of the receiver, with the ſpirit and oil well ſhaken about it, and pour all together into a large glaſs-funnel well lined with cap-paper, firſt moiſtened with ſpirit of fair water, through which the ſpirit, and as much of the volatile ſalt, as it and the phlegm can diſſolve, will paſs firſt, leaving the oil behind them in the paper, which muſt be ſeaſonably ſet aſide, or elſe the oil alſo, though more ſlowly, will paſs through the filtre. The phlegm, ſalt, and ſpirit muſt be rectified with a very gentle heat, ſo often, till the phlegm be perfectly ſeparated, and they leave no *fæces*: the oil alſo may be rectified two or three times from its own *caput mortuum* calcined, or elſe from ſalt of tartar, to deprive it of its muddineſs. The diſtempers, wherein this *arcanum* or ſpirit of man's blood is proper, are divers, but chiefly aſthmas, epilepſes, acute fevers, pleuriſies, and conſumptions. But to comply with my preſent haſte, I ſhall advertiſe you in the general, as to the uſe of this and the other remedies to be ſubſequently mentioned, that for them I muſt refer you to the particular narratives, which I ſhall ſcarce, if you ſeaſonably deſire them, refuſe you: and in the mean time, becauſe the volatile remedies are near enough of kin to each other, I ſhall add to this firſt proceſs (which is at the leaſt one of the nobleſt of them) ſome obſervations of a more general nature, that we may both of us avoid the trouble of needleſs repetitions.

## *OBSERVATIONS.*

Obſervations touching the manner of drawing the volatile ſalts and ſpirits of ſalt and blood, and other ſubſtances belonging to the animal kingdom.

1. I IGNORE not, that there are extant in *Burgravius*, *Beguinus*, and divers other chymical authors, very pompous and promiſing proceſſes of the eſſence of man's blood; to which they aſcribe ſuch ſtupendous faculties, as I ſhould not only wonder to find true, but admire, that they can hope the reader ſhould believe them ſo. But of theſe preparations, ſome being, as that of *Burgravius* in his *Biolychnium*, very myſtical and unlikely; and others, like *Beguinus* his *Q. E. ſanguinis humani*, exceeding

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* This, if I miſ-remember not, was the proportion I employed in the exacteſt of my experiments of this kind, but it ſeems to be eſſential to the goodneſs of the remedy; the ſpirit of wine ſerving chiefly but to keep the blood from corrupting.

laborious, and not ſo clear, I have never put myſelf to the trouble of making them; but I ſhall be very forward to acknowledge their excellency, if any man ſhall vouchſafe me an experimental conviction of it. For though I think the preparation of blood no bad one, yet I am far from daring to affirm there cannot be a better.

2. HE that intends to have any conſiderable quantity of this ſpirit and ſalt, muſt provide himſelf of a large proportion of blood, or elſe he is like to fall ſhort of his expectation; becauſe as full of ſpirits as blood is ſuppoſed to be, it yields commonly (at leaſt the beſt I have hitherto met with) no leſs than two thirds, or more, of phlegm, beſides a not deſpicable quantity of terreſtrial and unſerviceable matter.

3. IT is requiſite, both that the retort, wherein the dried blood is diſtilled, be pretty large and ſtrong, and that the fire be very carefully and gradually adminiſtered, leſt either the copious fumes break the too narrow veſſels, or the matter too haſtily urged boil over into the neck of the retort or the receiver; both which dangers this advertiſement may help you to avoid at a cheaper rate, than I, who have not been forewarned of them but by unwelcome experience.

4. THERE is a friend of mine, an excellent chymiſt, whoſe rare cures firſt gave me a value for remedies made of blood, who uſeth (as himſelf aſſureth me) to mingle with the ſpirit that other liquor, drawn over at firſt in a head and body, and twice or thrice rectified by itſelf. But that liquor conſiſting almoſt totally of the ſpirit of wine, and the not over-grateful phlegm of the blood, though there may perhaps be paſſed into it ſome of the more fugitive particles of the volatile ſalt; yet they being ſo few as ſcarce diſcernable, this liquor ſeems fitter to be made a vehicle, than an aſſociate of our ſpirit, and perhaps too is not in all caſes the moſt proper vehicle, in which it may be adminiſtred: (though if it were not for the ſpirit of wine, I ſhould ſomewhat ſuſpect, that the phlegm, though ſo deſtitute of the more active ingredients, as to be fit to be kept ſeparated from them, may not itſelf be quite devoid of ſpecifick virtues). But my eſteem of the artiſt I have mentioned, doth make me think it fit to acquaint you with his practice, notwithſtanding that hitherto his authority be the chief thing, that recommends it to me.

5. DIVERS ways may be propoſed of purifying this ſpirit and ſalt we are diſcourſing of, but having tried ſeveral, that which I now uſe is this, that follows: I put the ſalt, phlegm, and ſpirit together, in one of the higheſt and ſlendereſt bodies I can get, that the phlegm might not be able to aſcend eaſily into the head, and that the volatile ſalt may be the better ſeparated. Then in a very gentle heat (I moſt uſe that of a lamp-furnace) there will aſcend pure white and volatile ſalt, adhering to the cheeks and noſe of the glaſs-head, which if I deſire by itſelf, I ſweep it away before the ſpirit begins to riſe; but moſt commonly I ſuffer the diſtillation to proceed, and the aſcending ſpirit to carry down part of the volatile ſalt into the receiver, and ſo I continue the ſame degree of heat, till there ariſe ſo weak a ſpirit, that it plainly begins to diſſolve the volatile ſalt. Then ſhifting the receiver, I reſerve the ſtrong ſpirit and volatile ſalt by themſelves, and take the ſucceeding weaker ſpirit by itſelf alſo; to which, if I pleaſe to fortify it, I add as much of the volatile ſalt, formerly reſerved, as it is able to diſſolve. In the bottom of the cucurbit or phial there will remain a phlegmatick kind of liquor, which uſually contains ſome of the ſalt or ſpirit, and ſometimes too (which is ſomewhat odd) ſome of the oleaginous part of the blood, which did not before appear to have been aſſociated with the ſpirit, and to have paſſed through the filtre with it. This nauſeous liquor may be kept by itſelf, till you have a ſufficient quantity of it, to be worth the trouble of ſevering from it the nobler parts. The ſpirit and ſalt abovementioned may be again rectified *per ſe*, with the like gentle heat as before, ſo often, till they leave behind them no fæces, nor phlegm at all. But this is requiſite to be done only when, to maſter ſome ſtubborn diſeaſe, the medicine is to be exalted either

to its ſupreme, or at leaſt to ſome approaching degree of purity and efficacy; for otherwiſe ſo exquiſite a depuration is not always neceſſary.

6. As for the oleaginous part, which the fire forceth out of blood, my obſervations of it hitherto have ſo little agreed, that I dare as yet ſpeak but heſitantly concerning it. For ſometimes but one oil hath been drawn over, ſometimes two: and I remember, laſt year, a parcel of blood, that was kept in a dung-hill for many months, yielded us a blackiſh and muddy oil, a purely red one, and another of pale amber colour, which would not mingle with the darker; of each of which ſorts I yet reſerve ſome by me. This difference may poſſibly proceed partly from the previous preparation, or unpreparedneſs, of the blood, and partly from the various adminiſtration of the fire employed to diſtil it. But for the moſt part we find theſe animal ſubſtances (if the degrees of fire be orderly adminiſtred, and the heat ſufficiently intended towards the cloſe of the diſtillation) to yield a double oil; the one more light and pure, which ſwims upon the ſpirit; the other more muddy, aduſt, and ponderous, which ſinks to the bottom of it. The uſe of theſe oils hath, by reaſon of their fetidneſs, been by moſt authors abſolutely rejected; and even thoſe few, that do not altogether reject them, forbid their inward uſe, and allow them to be but externally imployed. But conſidering, *Pyrophilus*, how much of the efficacy both of plants and animals is obſerved to reſide in their oleaginous part, it ſeemed not improbable to me, that theſe oils might deſerve a better uſage, than either to be wholly thrown away, or confined to outward ſervices; and therefore having not long ſince given a friend of mine ſome pure yellow oil of mens blood, diſſolved in ſpirit of wine, to try upon a patient of his, ſick of a hectick fever (in which diſeaſe I had ſeen the ſpirit of blood very ſucceſsful) within a few days he brought me word of the unexpected recovery of his patient, to whom he adminiſtred our medicine (that I may not conceal from you that circumſtance) in *Balſamus Samech*, made with ſpirit of vinegar inſtead of ſpirit of wine; the remaining part of this yellow mingled oil I keep yet by me, to make further trials with it. And that ſuch oils may not be loſt, I have been attempting (for I am yet upon my trials) ſeveral ways to make them ſerviceable. Some of them, that are of a more pure and defecated nature, I have (which is not unworthy your noting) found capable of readily uniting with ſpirit of wine, with which they may be allayed at pleaſure: in others I have ſeparated the finer and more volatile part, by drawing them over with a very gentle heat in a retort half full of water, which will carry over the lighter part of the oil with it into the receiver, wherein the oil will ſwim upon it, and may be afterwards ſevered from it by a ſeparating glaſs, or any other convenient way; (but I fear that this method, though it finely clarifies oils, may rob them of the beſt part of the efficacy they may perchance derive from the latent admixtion of ſomewhat of the volatile ſalt:) at the bottom of the retort there will remain a dark and thick ſubſtance, whoſe nature I have not yet had opportunity to inquire into. Out of ſome oils (drawn from unprepared materials) which would not diſſolve in ſpirit of wine, I have, by digeſtion with ſpirit of wine, drawn much of the ſcent and taſte; the ſpirit probably imbibing ſome of the finer parts of the oil, or elſe aſſociating to itſelf ſome volatile ſalt, that yet lay lurking in it: for ſometimes I have obſerved oils, after long keeping, to let fall a volatile ſalt undiſcerned in them before. Having alſo ſometimes mingled the heavier and lighter oils of the ſame body with dephlegmated ſpirit of wine, and in a low retort drawn over what will riſe in a very gentle heat (inferiour to that of a balneum) I have found the ſpirit of wine to carry over with it ſo many of the more ſubtile and active parts of the oil, that it was more richly impregnated therewith, than you will be apt to expect. But of what uſe this oleaginous ſpirit may be in phyſick, I have not yet had time to conſult experience; which I hope will, ere long, teach me better ways of improving

the rejected oil, we have been ſpeaking of, than are thoſe almoſt obvious ones hitherto mentioned, wherein I am very far from acquieſcing; eſpecially ſince I cannot but ſuſpect, but ſuch active parts of ſuch concretes would be found very capable of a great improvement, if we were as ſkilful to give it them.

7. THE terreſtrial ſubſtance, that remains after the liquors are drawn off, if the blood have been duely prepared, affords but ſo inconſiderable a quantity of fixed ſalt, that unleſs the caput mortuum be exceeding copious, the alkali will hardly be worth extracting: beſides, that if it could be obtained in a not deſpicable quantity, I ſhould, whatever is pretended, very much doubt, whether it would be endowed with very extraordinary virtues; the violence of the fire uſually depriving fixed ſalts of the ſpecifick qualities of their concretes: and even in the firſt ſalt of ſerpents themſelves, I have not diſcerned other than the wonted properties of alkalizate ſalts.

8. BECAUSE you may ſometimes not have the leiſure to wait ſix weeks for the preparation of blood, and becauſe oftentimes the occaſion of uſing the medicines we have been deſcribing, may be ſo haſty and urgent, that unleſs ſome ſpeedy courſe to relieve them be taken, before the phyſick can be prepared, the patients will be dead; I think it not amiſs, *Pyrophilus*, to advertiſe you, that though without any previous preparation of blood you ſhould immediately diſtil it, provided an orderly gradation of heat be carefully obſerved, it will yield you a reddiſh ſpirit, and (beſides an oil or two) a volatile ſalt; which being rectified, are ſo little inferiour, in any properties diſcernible by the ſmell or taſte, to the ſalt and ſpirit of predigeſted blood, that it is very probable their efficacy will emulate, though not altogether equal, that of the more laboriouſly prepared.

9. AND becauſe it is difficult to get the blood of healthy men, and perhaps not ſafe to uſe that of unſound perſons; and becauſe many have a ſtrong averſion, and ſome an inſuperable, though groundleſs abhorrency, from medicines made of man's blood, I have thought it not amiſs to try, whether that of ſome other animals prepared the ſame way, might not afford us as hopeful medicines. And becauſe the blood of deer is chiefly (and perhaps not cauſleſly) commended by authors, we have handled it according to the foregoing proceſs, and thereby obtained of it a ſpirit, and ſalt, and oil, whoſe penetrancy, and other reſemblances, make us hope, that they may prove good ſuccedanea, in the defect of thoſe analogous remedies (drawn from human materials) which we have been treating of.

AND to this let me, *Pyrophilus*, on this occaſion, annex this advertiſement, that though in theſe papers, and what I have further written of preparations of this nature, I name not any great number of concretes, as having drawn their volatile ſalts and ſpirits, yet I have endeavoured in theſe diſcourſes to give you, in the inſtances I inſiſt on, ſo much variety of examples, that either by the proceſſes therein ſet down, or by the analogy to them, you may, I ſuppoſe, be directed, with the help of a few trials, to obtain the volatile ſalts and ſpirits of moſt concretes, that belong to the animal kingdom, and that are capable of affording any. For by the method we preſcribe, a little varied according to the exigencies of particular bodies to be diſtilled, we have drawn the ſpirits, ſalts, and oils of ſheep's blood, eels, vipers, *&c.* the latter of which yield a ſalt and liquor, which in *Italy*, by divers learned men, is ſuperlatively extolled againſt obſtructions, foulneſs of the blood, and I know not how many diſeaſes proceeding from theſe two general cauſes. And though I dare not deny, that divers of thoſe praiſes may be well enough deſerved by the remedies, to which they are aſcribed; yet I am not apt to think them much ſuperiour to the generality of volatile ſalts: and even the ſpirit and ſalt of ſheep's blood it ſelf did, by their penetrancy of taſte, and fugitiveneſs in gentle heats, promiſe little leſs efficacy than thoſe others ſo much celebrated medicines.

How to draw tinctures, as of ſulphur, &c. with the ſaline ſpirits.

10. Nor is it only by being adminiſtred itſelf, that one of this ſulphureous and ſubtle kind of ſpirits may become a good remedy, but alſo by its being made a menſtruum to prepare other bodies: for it will extract tinctures out of ſeveral ſulphureous and reſinous concretes, whoſe finer parts, by being aſſociated with ſo piercing a vehicle, may probably gain a more intimate admiſſion into the body, and have their virtues conveyed farther than otherwiſe they would reach. And a learned doctor, to whom I recommended ſuch kind of remedies, confeſſed to me, that by the bare extractions of appropriated vegetables themſelves, with ſpirit of urine, he performed no ſmall matter. But one difficulty you may meet with in drawing the tincture of minerals, and other very compact bodies, even with good ſpirit of urine; (for that I account to be the cheapeſt of theſe volatile menſtruums, and the moſt eaſy to be obtained in good quantities). For we have found, but with a little heat, the more fugitive particles to aſcend to the upper parts of the glaſs, and there faſten themſelves in the form of a ſalt; by whoſe receſs, the debilitated liquor was diſabled from drawing the tincture ſo powerfully as was expected: wherefore we were reduced to make our extractions in ſhort-necked glaſs-eggs or phials exquiſitely ſtopped, (which may alſo be placed ſtooping in the ſand) and when we perceived much to be lodged in the necks of the veſſels, by barely inverting them, the hot liquor ſoon reimbibed the ſalt, and was fit to be placed again in ſand; ſo that, notwithſtanding this difficulty, we are able by this means, in no long time, to impregnate the ſpirit of urine, or of hartſhorn (for I do not perfectly remember, which it was) with the tincture of flowers of ſulphur, which may probably prove a noble medicine in divers affections of the lungs, ſince in them theſe volatile liquors alone have been found very effectual. And I remember, I have ſometimes made a much ſhorter, and more odd preparation (which at any time you may command) of crude ſulphur, whereby in not many hours I have, by the means of ſalts, brought over ſuch a ſulphureous liquor or tincture, as even in the receiver was of a red colour, as well as of a ſtrongly ſulphureous ſcent.

## To Page 135, *&c.*
## Where *Ens Veneris* is treated of.

How the author firſt happened upon the preparation of Ens Veneris.

BUT before I enter upon particulars, I think it will not be amiſs to tell you, how this preparation firſt occurred to us, becauſe by that information your happier genius may peradventure hereafter be prompted to improve this remedy, or to deviſe one more approaching to the nature and excellency of that, which we endeavoured, but with very imperfect ſucceſs, to light on, or equal, by our *Ens Veneris*. I muſt then tell you, that an induſtrious chymiſt (of our acquaintance) and I, chancing to read one day together that odd treatiſe of *Helmont*, which he calls *Butler*; when we had attentively peruſed what he delivers of the nature, as well as ſcarce credible virtues of the *lapis Butleri* he there mentions, we fell into very ſerious thoughts, what might be the matter of ſo admirable a medicine, and the hopefulleſt manner of preparing that matter. And having freely propoſed to one another our conjectures, and examined them by what is delivered by *Helmont*, concerning the preparation of *Butler*'s ſtone, or ſome emulous remedy, we at length concurred in concluding, that either the *lapis Butleri* (as our author calls it) or at leaſt ſome medicine of an approaching efficacy, might (if *Helmont* did not miſ-inform us) be prepared by deſtroying (as far as we could by calcination) the body of copper, and then ſubliming it with ſal armoniack.

And becauſe the body of *Venus* ſeems leſs locked up in good vitriol, than its metalline form, we concluded, that it was beſt to calcine rather the vitriol, than the copper it ſelf; and, having freed the colcothar from its ſeparable ſalts, ſo to force it up with ſal armionack. But the perſon I diſcourſed with, ſeeming ſomewhat diffident of this proceſs, by his unwillingneſs to attempt it, I deſired, and eaſily perſuaded him, at leaſt to put himſelf to the trouble of trying it with the requiſites to the work, which I undertook to provide, being at that time unable to proſecute it my ſelf, for want of a fit furnace in the place where I then chanced to lodge. And though at firſt we did not hit upon the beſt and moſt compendious way, yet during the ſublimation, he being ſuddenly ſurprized, as both himſelf and his domeſticks two days after told me, with a fit of ſickneſs, attended with very horrid and ſeemingly peſtilential ſymptoms, was reduced to take ſome of this medicine out of the veſſels before the due time, and upon the uſe of it found, as he told me, an almoſt immediate ceſſation of thoſe dreadful ſymptoms, but not of the paleneſs they had produced. This firſt proſperous experiment emboldened us to give our remedy the title of *Primum Ens Veneris*, which, for brevity's ſake, is wont to be called *Ens Veneris*; though I am far from thinking, that it is the admirable medicine, to which *Helmont* gives that name, at leaſt, if his *Ens Veneris* did really deſerve half the praiſes by him aſcribed to it. But ſuch as ours is, I ſhall now (as time and my yet incomplete trials will permit) acquaint you with that proceſs of it, which (among ſome others) we are moſt wont to employ, as the moſt eaſy, ſimple, and genuine.

The proceſs uſed by the author for the making of Ens Veneris.

Take then of the beſt Hungarian, or, if you cannot procure that, of the beſt Dantzick, or other good venereal vitriol, what quantity you pleaſe; calcine it in a ſtrong fire, till it be of a dark red; dulcify it by ſuch frequent affuſions of hot water, that at length the water, that hath paſſed through it, appear full as taſteleſs, as when it was poured on it. Let this, thus exquiſitely dulcified colcothar, when it is thoroughly dry, be very diligently ground with about an equal weight of good ſal armoniack, and let this mixture be put into a glaſs retort, and either in as ſtrong a heat as can conveniently be given in ſand, or elſe in a naked fire, force up as much of it as you can to the top of the neck of the retort; and this ſublimation being ended, out of the broken retort (laying the caput mortuum aſide) take all the ſublimate, and grind it well again, that if in any part the ſal armoniack appear ſublimed by it ſelf, it may be re-incorporated with the colcothar; reſublime this mixture *per ſe* in a glaſs-retort as before, and, if you pleaſe, you may once more elevate this ſecond ſublimate, but we have not found that always needful. And for the better underſtanding of this proceſs, be pleaſed to take notice of the following particulars.

Divers particular animadverſions concerning the preparations.

First, We have always preferred ſuch vitriol as abounds with copper, before our common Engliſh vitriol, about the making of which, thoſe that keep the copperas-work at *Deptford* are wont, as themſelves have upon the place informed me, to uſe good ſtore of iron to increaſe the quantity of their vitriol.

Secondly, If you be unwilling to loſe the phlegm, ſpirit, and oil of that vitriol, with which you deſign to make *Ens Veneris*, you may diſtil them away in an earthen retort, or one of glaſs well coated. But though it be well known, that the diſtillation of oil of vitriol requires a very intenſe and laſting fire, (ſo that unleſs you have need of the liquors, the beſt way will be without any ceremony to calcine the vitriol in a naked fire and open) yet afterwards it will be for the moſt part requiſite, farther to calcine the caput mortuum in an open veſſel. For you muſt take notice, that unleſs the vitriol be very thoroughly calcined, it will be very troubleſome for you to dulcify it; and ſometimes we have obſerved, that the caput mortuum which looked red, and ſeemed indifferently well calcined, hath been, almoſt like crude vitriol, diſſolved in the fair water, which was poured on it, to dulcify it. The weight of the calx, in reference to the vitriol of which it was made, we cannot eaſily determine; but we have ſometimes found it neceſſary to reduce the vitriol to leſs, perhaps much leſs than half its weight, to make fit for dulcification.

Thirdly, The water, that hath been poured off the firſt and ſecond time, to edulcorate the calcined vitriol, may be filtrated and ſteamed away, till it come almoſt to the conſiſtence of a ſyrup or honey, and then may be put into a cold place to ſhoot; for after this manner we have ſometimes had many very regularly figured cryſtals or grains of ſalt: I ſay ſometimes, becauſe ſometimes alſo you may find it neceſſary to abſtract all the water, to obtain the whitiſh ſalt of vitriol, which we have known uſed as a good vomit, and which *Angelus Sala*, none of the leaſt ſober of the chymical writers, doth highly extol as an excellent emetick, in his *Ternary of vomitive remedies*, where he diſcourſeth at large of the virtues of it, and the way of adminiſtring it. And of this ſalt, as chymiſts are pleaſed to call it, we have had out of calcined copperas a very great quantity, and have ſometimes obſerved it to have been almoſt as deeply coloured, as the vitriol it ſelf was before calcination.

Fourthly, We ſeveral times tried to ſublime dulcified colcothar with ſal armoniack, in retorts and urinals placed in ſand; but whether by reaſon of the fixedneſs of the colcothar, or becauſe the furnace we were fain to uſe, though no very bad one, was none of the beſt, we never could that way obtain any conſiderable quantity of the deſired ſublimate, and that, which did aſcend, was but of a faint colour: wherefore, unleſs you have an extraordinary good ſand-furnace, if you will make uſe of glaſs-veſſels, which is the cleaneſt way, you will find it expedient to ſublime your colcothar in coated retorts with an open fire, except you have the dexterity to ſublime in a naked fire with glaſs retorts uncoated, which we have divers times ſeen performed by heating the bottom of the retort by degrees, and then placing it upon embers, with coals round about it, but to be kindled at a diſtance from it: for if this courſe be watchfully followed, the retort will be ſo well nealed, before it be reduced to endure any intenſe degree of heat, that after a while you may ſafely lay thoroughly kindled coals, not only round about it, but upon the top of it, (which needs not to be done till towards the end of the operation) and thereby drive moſt of the ſublimate into one lump, and into the neck of the retort. And by this way you may ſublime any furnace upon a bare hearth; but if you deſire to give a more intenſe heat, you may lay firſt ſome warm aſhes in an ordinary iron pot, and having with them, and a few ſmall coals well kindled, nealed your retort, you may afterwards proſecute the ſublimation in the ſame pot, which being once thoroughly heated it ſelf by the fire, will afterwards conſiderably increaſe the heat of it.

Fifthly, Though it be moſt commonly requiſite to reſublime the ſublimate, that comes the firſt time up, that the ſalt and colcothar may be more exquiſitely mixed, yet as far as we can gueſs by ſome trials, it will not be expedient to reſublime it above once or (at moſt) twice. For in thoſe trials we have found the *Ens Veneris* oftner reſublimed of a paler colour, than that which was reſublimed but once. And *(NB)* perhaps, by farther ſublimations, the ſalt, inſtead of being more intimately united with the colcothar, may be almoſt totally ſevered from it, according to what we elſewhere in other caſes declare.

Sixthly, Of theſe ſublimates, that, which hath the higheſt colour, ſeems to be the beſt, as being moſt enriched with the colcothar, from whence the redneſs proceeds. But at the firſt ſublimation I have often obſerved a pretty part of the ſal armoniack to come up firſt white by itſelf, eſpecially if it had not been very diligently mixed with the colcothar. But at the ſecond ſublimation the ingredients (which we have ſometimes almoſt totally forced up without leaving a caput mortuum in the bottom of the retort) will be more accurately mixed, and the ſublimate will appear yellow, and perhaps reddiſh, of which ſort we have ſometimes had, when the operation hath been carefully managed.

SEVENTHLY, How great a proportion of the ingredients committed to ſublimation will ariſe in the form of *Ens Veneris*, we dare not preciſely define; but ſublimate amounting to the fourth part of the whole mixture, you will ſcarce, if you work ſkilfully, fail of.

EIGHTHLY, We ſometimes made a ſublimate of equal parts of pure ſal armoniack and ſalt of tartar, both of them very throughly dried, (for elſe they will be apt to yield rather a ſpirit than a ſublimate) well ground together, and ſo ſublimed. And with this ſublimate inſtead of ſimple ſal armoniac we intended to make *Ens Veneris*, but by ſome intervening accidents and avocations we were not able to perfect the experiment, of which we nevertheleſs think it fit to give you this hint, becauſe of the great efficacy, which an excellent phyſician of my acquaintance, to whom I gave ſome of it, aſſures me he has found in it againſt obſtructions, and ſome diſtempers, that are wont to ſpring from them.

NINTHLY, When you are about to make your firſt ſublimate, you may, if you pleaſe, lute to the retort, whereinto you put the ingredients, a ſmall receiver to catch the liquor that oftentimes comes over. For that liquor, though you will very ſeldom get much of it, yet it may be worth your preſerving, by reaſon of the volatile and urinous ſalt wherewith it will ſometimes ſo abound, that it may paſs for a weak ſpirit of ſal armoniack.

TENTHLY, The caput mortuum, that remains after the firſt ſublimation, may be put into a clean glaſs, and ſet in a cellar, where it will run *per deliquium*, into a thick and high coloured liquor, very richly impregnated (as we elſewhere manifeſt on another occaſion) with the ſomewhat opened body of copper; from whence, if half thoſe praiſes be true, which even the beſt chymiſts are pleaſed to give to copper, it may be very well concluded to have derived no ſmall virtues againſt ulcers, and divers affections, which we are not here to inſiſt on.

ELEVENTHLY, We have ſometimes doubted whether or no our *Ens Veneris* did really contain any thing of cupreous or colcotharine in it, partly becauſe of the fixedneſs or ſluggiſhneſs of colcothar, and of the copper therein contained; and partly becauſe, that if ſal armoniack be two or three times ſublimed by it ſelf, its flowers frequently enough will aſcend yellow, like the paler ſort of *Ens Veneris*. But firſt, that ſal armoniac is capable of carrying up even fixed and ſluggiſh bodies, ſeemed probable to us, partly upon our incorporating and ſubliming it with finely powdered corals, (from which, though but very little of it aſcended, yet ſome of that little was no leſs red, than the corals themſelves before their being beaten) and partly upon our ſubliming it from copper, both crude and calcined, ſince of either of thoſe bodies it carried up a little with it, as appeared by the blue colour of ſome parts of the ſublimates.

AND ſecondly, that the reddiſhneſs of our *Ens Veneris* proceeded partly, if not altogether, from the colcothar, ſeemed probable to us, not only by the taſte, and ſome other properties of it, but alſo by this, that having knowingly committed the firſt ſublimate to a fire too weak to reſublime it; and having after ſome hours taken the veſſel out of the ſand, we found that the fire, which we ſuppoſed was not ſtrong enough to carryup the whole matter, had raiſed the ſal armoniack to the upper part of the urinal in flowers, that were either white or but pale yellow; whereas the remaining part of the mixture, that lay in good quantity in the bottom of the veſſel, was of a deep red, and a fragment of it of about the bigneſs of a large pea, being caſt upon glowing coals, and nimbly blown with a pair of bellows, coloured the flame with ſomewhat greeniſh blue, like that, but more faint, which we elſewhere have obſerved to proceed from the well-opened body of copper.

But thoſe trials, I confeſs, would rather increaſe my doubts than leſſen them, becauſe in our *Ens Veneris* the colour is not blue, but reddiſh; if I did not conſider, that colcothar is a body, that conſiſts of ſome other matter beſides common copper, (as it is alſo far more difficult to reduce, though but in part, into a metal, than is vulgar calcined copper) and conſequently when corpuſcles of differing natures are by the ſal armoniack elevated together, that, which is not metalline, may, with the aſſiſtance of the fire's operation, alter the nature of what it is, and thereby produce a colour differing from blue. But to diſpatch whatever further trials ſhall inform us, touching this queſtion, whether or no any true and reducible copper do make an ingredient in our *Ens Veneris*, yet there being in colcothar other parts as well as thoſe, that by fuſion you may reduce into a pure metal, and our remedy ſeeming by its ſomniferous property to partake of them, it will not be neceſſary to the giving our medicine a right to the appellation I commonly chooſe of *Flores Colcotharis*, that in it there is ſomething of the colcothar carried up, though poſſibly the quantity be but ſmall, and not all reducible into a metalline form. But perhaps the queſtion is not worth a longer debate, it being ſufficient to excuſe the name, and recommend the thing to ſuch a perſon as you, that colcothar is employed in the making of it, and that the thing prepared is a noble medicine, and hath ſome of the great virtues aſcribed to vitriol; whether that mineral be an ingredient of it, or no.

The doſe and uſe of Ens Veneris.

The doſe of *Ens Veneris* may be very much varied: to little children we give ſometimes one, ſometimes two, and ſometimes three grains for many nights together, as we find them able, without inconvenience, to bear the operation. To perſons of ripe years we commonly adminiſter four, five or ſix grains at a time. But one, to whom we have given quantities of it to lie by him, tells us, that he hath taken to above thirty grains at once without any inconvenience. We are wont to give it in two or three ſpoonfuls of ſack, or other wine, if the conſtitution of the patient, or the nature of the diſeaſe do not forbid it; and, in ſuch caſes, we give it in any cordial liquor, that is temperate, or any other convenient vehicle.

To children it may be given in beer, or ale, or clear poſſet-drink, but not in milk. If the patient hath ſupped at a ſeaſonable hour, we commonly adminiſter it, when he is going to ſleep. It works for the moſt part by ſweat and a little by urine, but more by ſweat at the beginning, than after the body is uſed to it; yet to ſome bodies it proves ſo ſudorifick, that two grains, or leſs of it, have often made me ſweat. That it hath once proved emetick, I have heard, but never obſerved it my ſelf to provoke vomits.

As for the medical uſe of *Ens Veneris*, divers great phyſicians will perhaps think it were not deſpicable, though it were no other than oftentimes to prove a ſafe and moderately ſomniferous medicine in fevers, without having any thing in it of opium, whoſe narcorick power they find as difficult to correct, as oftentimes proves dangerous, when being not well corrected, it is adminiſtred without very great circumſpection. But—*********

### To the 141, 142, 143, 144th Pages.

[*Finding among my looſe notes, together with thoſe, that do immediately concern the preparations of ſulphur and hartſhorn (delivered in theſe pages) ſome other particulars, that may alſo ſerve, either to afford ſome light to readers leſs ſkilled in chymiſtry, or contribute ſomewhat or other towards the relief of ſome patients, I am content to let thoſe papers go together, as I long ſince addreſſed them to a friend.*]

Of hartſhorn.

HArtſhorn, *Pyrophilus*, is a heteroclite body in nature, which hath but few reſemblers in the univerſe; for it grows to a conſiderable bulk like a vegetable, and is (unlike moſt other horns of animals) at certain ſet periods of time, deciduous; and though it be of a bony ſubſtance, yet that middle part of it which differs from the reſt in colour, does (at leaſt in grown horns) much more reſemble the pith of ſome plants than the marrow of bones: and yet this plant-animal (if I may ſo call it) does, when ſkilfully expoſed to the fire, afford the ſame differing ſubſtances, with the blood, fleſh, and other part of animals. It is no wonder therefore, if phyſicians and chymiſts have hoped to find extraordinary virtues in ſo extraordinary a ſubject, of which we ſhall paſs by the uſual preparations, as not ſo pertinent to our preſent deſign, inſinuating only in the general, that though even the more vulgar preparations, as well as that which phyſicians have been pleaſed to call philoſophical, afford us medicines not deſpicable; yet theſe are much inferiour to thoſe remedies wherewith dexterous diſtillations are capable of preſenting us. And certainly if we allow of the chymical theory, (whoſe truth in theſe papers I queſtion not) harts-horn being generally acknowledged to be endued with properties very friendly to our nature, and even thoſe ways of preparing it, wherein the nobler and more active parts are not truly freed from thoſe cumberſome ones that fetter him, and hinder them to diſplay their powerful energies, proving yet oftentimes not unavailable: the ſpirit and ſalt of harts-horn would be in more requeſt, were not men deterred from making trials of it, partly by the over-apprehended unpleaſantneſs of the ſmell, and partly by the difficulties commonly met with in its diſtillation; the latter of which determents hath ſo frighted even chymiſts from diſtilling this cordial ſubſtance, that we have very rarely ſeen any, either ſpirit or ſalt of hartſhorn, ſave what our ſelves have been induced to prepare.

Three ways of diſtilling hartſhorn.

THERE are three ways propoſed by the authors I have met with, to diſtil hartſhorn: the one in coated glaſs retorts; the other in earthen ones; and the third in *Glauber*'s ſecond philoſophical furnace.

IN the firſt of theſe ways, ſome very ſkilful diſtillers, that have often practiſed it, have ſo complained of their frequent breaking their veſſels by the copiouſneſs, and impetuoſity of the fumes, that ruſh out of the matter, when it once begins to be preſt with a conſiderable heat, that I confeſs to you ingenuouſly, *Pyrophilus*, they have hitherto frighted me from making trial of that way; though I ſee no very great reaſon why, by a ſlow and regular gradation of the fire, the miſchances incident to this way of diſtillation may not (at leaſt moſt commonly) be avoided.

To diſtil the matter we diſcourſe of in earthen retorts, is a ſafer way than the former, if the earth be cloſe and good, and have been ſufficiently baked; as we find in the right *Heſſian* retorts, wherein we have known the operation proceed very proſperouſly, though a conſiderable quantity of the matter hath been diſtilled at once; but the retorts made of earth, that is ſpongy, or any other ways unfit, or in whoſe baking fuel hath been ſpared, are commonly (as experience hath informed us) improper for this ſervice, wherein they are eaſily broken: beſides that it is much to be feared, that all retorts made of earth, except it be extraordinarily compact and baked, are apt to imbibe the more ſubtile and more penetrant parts of hartſhorn, nd other volatile ſubſtances diſtilled in them; which we have obſerved in ſome, wherein the matter hath tranſudated quite through the ſubſtance of the retort, and been manifeſtly diſcernable on the outſide of it.

The third way of diſtilling harts-horn is performed by the inſtrument deſcribed by *Glauber*, in his ſecond philoſophical furnace: but neither is this way without its inconveniencies: for beſides that, if the earth whereof the veſſel to be employed is made, be not very good and well baked earth, it will be apt to crack, in ſo violent a fire, as is requiſite in this way of diſtillation, or elſe it will imbibe part of the fineſt ſpirit it ſhould tranſmit into the receiver: and beſides that it is difficult to work long this way, without letting ſome of the active part of the ſpirit eſcape between the wide orifice of the retort and the cover: beſides theſe inconveniences, I ſay, it is to be feared, that the matter being to be caſt immediately into the veſſel, made red-hot before-hand, it will receive a ſtronger empyreuma, or impreſſion of the fire, than it would do in the ordinary way of diſtillation; wherein the fire being orderly and ſucceſſively increaſed, much of the ſpirit and ſalt comes over into the receiver, before that laſt degree of fire is adminiſtred; which is requiſite chiefly to force over the more ſluggiſh and heavy oil, which therefore (to ſpeak congruouſly to the moſt received theory of diſtillation) ſavours much more of the fire, and is grown almoſt infamous for its aduſtion.

But notwithſtanding theſe inconveniencies, *Pyrophilus*, we have found theſe retorts of *Glauber*'s not unſerviceable, when we have had occaſion to diſtil conſiderable quantities of ſuch materials, as were not ſo precious, as to make the loſs of a part of what they were to afford us, conſiderable.

And this advertiſement may take place, eſpecially if you take along with you what we have declared, touching the ways we ſubſtitute, to avoid, as much as may be, the newly objected inconveniences. But having in other papers taken notice particularly enough of the ways we mean, I ſhall forbear to mention them in this place, though one of them may eaſily be made applicable, as experience hath aſſured us, even to ordinary retorts: for it is not difficult to apply *theſe*, the perforated receivers, which being almoſt of the ſhape of pears, open at both ends, by holes of about two or three inches diameter (according to the capacity of the veſſel) may be with great facility taken aſunder and made clean; and may, by the convenient inſertion of their extremities into one another, be eaſily luted together (in a level) two or three, or as many of them as neceſſity ſhall require: and then, provided there be applied to the remoter extremity of the laſt of them, ſome convenient veſſel open but at one end, the receivers will very ſeldom break: the fumes that come over too copiouſly to be contained in one of them, paſſing freely thence into the ſecond or the third (for we very rarely exceed three in all) which will be manifeſtly cool, and ſo, ſpeedily turn into liquor, the fumes it receives; whilſt the firſt recipient is perhaps hotter than the hand can endure: but of theſe mechanical contrivances elſewhere.

Animadverſions on ſome preparations of hartſhorn of Glauber and Hartman.

Now whereas *Glauber* preſcribes to mingle with the diſtilled liquors of hartſhorn rectified ſpirit of wine, to waſh out the volatile ſalt, and directs the diſtilling again of both thoſe ſpirits (of wine and hartſhorn) together; his method of proceeding may be juſtly queſtioned. For firſt, dephlegmed ſpirit of wine will not ſo readily, in the way he ſuppoſeth, diſſolve the volatile ſalt of hartſhorn; and next, the ſpirit this way drawn is not a ſimple ſpirit of hartſhorn, but a compound liquor of the ſpirit of hartſhorn, and that of wine; the latter of which may poſſibly, in divers caſes, rather impair than improve the virtue of the former. For ſpirit of hartſhorn, by reaſon of its opening and reſolving, as well as cordial virtues, is ſafely and ſucceſsfully given in fevers, wherein it is not obſerved to inflame the blood; whereas ſpirit of wine in ſuch caſes is counted dangerous. And this brings into my thoughts a very queſtionable preparation of the experienced and ingenious *Hartman*, who much extols for the worms in the ſtomach, ſpirit of hartſhorn in general, but eſpecially that which he is pleaſed to call *Eſſenſificated*, (that is, as himſelf expounds it) with which its own fixed ſalt, extracted with ſome convenient water, and its volatile duly depurated, have been diſſolved and united. For firſt, the fixed ſalt of hartſhorn hath been perhaps never yet prepared by any man: and if hartſhorn doth yield a fixed ſalt (as I dare not abſolutely deny, but that out of many pounds a few grains may be extracted) it may well be doubted, whether that ſalt be endowed with ſpecifical virtues: and next, the ſpirit of hartſhorn, if it be well dephlegmed, will not (for aught I could ever find) diſſolve its own ſalt, unleſs aſſiſted by the external warmth of the ambient air. Inſomuch that I uſually keep the ſpirit and ſalt in the ſame phial, where they remain unmixed; and the ſpirit, that will diſſolve any of its own ſalt, I account not ſufficiently dephlegmed, but to have yet an aqueous alloy, whereby the ſalt is imbibed. And I remember, that having once exquiſitely rectified ſome ſpirit of hartſhorn, and cloſed it up in a phial, after divers months it let fall a conſiderable quantity of volatile ſalt; ſo far was it from being able, without the help of ſome peculiar way, to have diſſolved more, had I caſt more into it. I deny not, that the ſpirit of hartſhorn may, by the mediation of heat, be brought to take in ſome of the ſalt of the ſame body: but of what uſe this violent impregnation of the liquor can be, unleſs it be quickly adminiſtered, I do not yet underſtand; having often ſeen the ſpirit let fall again in the cold, the volatile ſalt it had diſſolved by the aſſiſtance of heat.

Tract. Chym. p. 190.

AND having thus, *Pyrophilus*, laid before you the difficulties we have met with, in the above-mentioned ways of making of ſpirit of hartſhorn, propoſed by authors, (neither of which we would yet have you altogether reject) I muſt acquaint you, with our having attempted a fourth way, which when the matter to be diſtilled is not very much, I chuſe rather to practiſe than any of the other, as hitherto ſeeming more ſafe and free from inconveniences. Take then (for inſtance) two pounds of hartſhorn broken on an anvil into pieces, each of about the bigneſs of one's finger, (for if it be raſped, there is danger, that it ſhould emit its fumes too plentifully at once) and put it into a ſtrong glaſs-retort uncoated, big enough to contain at leaſt twice as much matter: ſet this in ſand, and fit to it a pretty large and ſtrong (either ſingle or double) receiver; then give a ſlow fire for three, four, or ſix hours, to ſend away firſt the phlegm, and more fugitive parts of the ſpirit. Then increaſing the fire, but warily, and gradually for divers hours, drive over the ſpirit (which is wont to drop down ſomewhat tincted) and the more volatile parts of the ſalt; and at length intend your fire till the bottom of the retort be glowing hot, and heap alſo at laſt quick coals upon the ſand round about the retort, to give, as it were, a fire of ſuppreſſion, and ſo force over the more ſluggiſh remaining parts of the ſalt, and with it the oil: all which, are to be afterwards proceeded with, according to the directions given concerning the ſpirit, ſalt, and oil of man's blood; which having been ſufficiently inſiſted on before, will not (I ſuppoſe) need to be repeated now. Only it may not be impertinent to advertiſe you, 1. That we have more than once had the bottom of the retort melted, yet not broken, the melted glaſs being ſupported by the ſubſtrated ſand. 2. That ſometimes in filtration, ſome of the thinner parts of the oil have unperceivedly paſſed through the paper with the ſpirit and ſalt, and have not been diſcovered, but by rectification; wherein I have almoſt admired to ſee the oil, with a gentle heat of a lamp, aſcend to the top of a very tall head and body: touching which circumſtance it may yet be farther inquired, whether it proceed barely from the volatileneſs of the oil itſelf, or alſo from its being carried up by the ſalt and ſpirit, wherewith it was aſſociated. 3. That by

A fourth way of preparation of hartſhorn, uſed by the author.

by this way of diſtillation, we uſually have out of a pound of hartſhorn between four and five ounces (ſeldom or never ſo little as four, and often nearer five) of volatile ſalt, ſpirit, oil, and phlegm; (of the laſt of which, if the hartſhorn be not recent, there will be no great quantity) and when we diſtilled two pound of the matter at a time, we found the operation to ſucceed altogether as well, and to yield us a fully proportionable quantity of liquor.

The uſe and effects of the ſpirit of ſalt of hartſhorn, and the doſe of it.

THE virtues of the ſpirit and ſalt of hartſhorn, which differ not much in doſe, or efficacy, are probably very great in divers diſtempers, wherein we have yet made no trial of them. For they are conſiderable in reſiſting putrefaction, comforting nature, opening obſtructions, mortifying the acidities it meets with in the blood; and, by rendering that volatile, promoting its circulation, we have known conſiderable effects of it in fevers, pleuriſies, obſtructions of the meſentery, and ſpleen; and chiefly (which perhaps you will think ſtrange) in coughs and diſtempers of the brain, and nervous parts: in ſo much that I have, by God's bleſſing, ſometimes ſtopped very violent (but not inveterate coughs) with this medicine in a few hours. And preſcribing it to one, who was almoſt daily aſſaulted with epileptical fits, a few doſes of it did, in a pretty while at firſt, make his fits come but ſeldom, and after, not at all: but whether he be perfectly cured, not having heard of him of late, nor having had opportunity to make farther trial of the medicine in that diſeaſe, I am not certain. We preſcribed it likewiſe, not long ſince, to a perſon, who had long lain both diſtracted, and almoſt bedrid, and was in a ſhort time ſtrangely relieved by the uſe of it, though not perfectly cured, (perhaps, becauſe the patient took but little of the medicine, we being, then, not well ſtored with it) and on ſome, that have been by fevers rendered ſtupid, it hath had very eminent operations. But for a farther account of its virtues, I muſt refer you to the particular narratives I may, when we meet, give you by word of mouth: and till then, it may ſuffice to tell you, that it works chiefly by ſweat (and ſomewhat by urine) without being obſerved to leave behind it ſuch heat as divers ſudorificks are wont to do: only there muſt be care not to adminiſter it, when the *primæ viæ* and paſſages are too much ſtuffed and choaked up by groſs humours, leſt by agitating the blood, and putting it into a nimble motion, it occaſion greater obſtructions. The doſe is from five drops, or grains, to a drachm (ten or fifteen drops are wont to make me ſweat) in wine, *carduus benedictus* water, or any vehicle appropriated to the diſeaſe; only taking care, that nothing acid be adminiſtered with it, becauſe acid and ſulphureous ſalts mortify, and diſarm one another. *Hartman* commends it againſt the worms of the ſtomach, againſt which it may very probably be available, by reaſon of its penetrant and ſaline nature, and its enmity to putrefaction. *Glauber* writes, that the oil rectified from ſalt of tartar cures quartans, and inward wounds, and cures the pains produced by falls, convulſions, *&c.* being adminiſtered from ſix to twenty drops to a patient placed in his bed to ſweat after it: but of this my experience will not enable me to ſay any thing. And I fear, *Pyrophilus*, that I have already too long entertained you about hartſhorn: and yet I fear too, that you expect that, before I forſake this ſubject, I ſhould ſay ſomething to you concerning a much controverted particular relating thereunto. The inquiry is, whether or no, when it is diſtilled, the ſalt diſpoſe itſelf, in the receiver, into the figures of hartſhorn: the affirmative is maintained by many chymiſts, and a friend of mine, who is very ſevere, and not at all credulous, having aſſured me, that he himſelf had obſerved the inſide of his receiver over-laid with ſuch figures or horns, I dare not deny, but that accidentally the particles of the volatile ſalt may ſometimes repreſent as well the ſhape of hartſhorns, as of divers other things. But for our parts, having ſeveral ways, and not unfrequently diſtilled that matter, we could never ſee the pretended ſaline hartſhorns, ſo clearly as we thought we ſaw

Q. Whether in the diſtillation of hartſhorn, the ſalt diſpoſe it ſelf into the figure of the horn.

ſaw cauſe to eſteem, that thoſe who affirmed they conſtantly ſaw them ſo diſtinctly, looked through the ſpectacles of prepoſſeſſed imagination: not to mention, that it is the uſual method of nature in ſalts to make the bigger concretions of the ſame figures with the ſmaller grains, as we obſerve in nitre, roch-allum, *&c.* And the grains of the ſalt of hartſhorn, though I have attentively enough conſidered their ſhapes, I remember not ever to have obſerved of a figure like that of the horns they came from: but it is the nature of volatile ſalts to faſten themſelves to the receiver in various figures, according as the degree of fire, that urges them up, and other concurrent circumſtances, do chance to exact; and conſonantly hereunto, we have often obſerved the volatile ſalt of the ſame hartſhorn to be very variouſly figured in the ſame receiver. And I remember, that, not long ſince, ſubliming ſome volatile ſalt of urine, it adhered to the upper part of the veſſel in figures, much liker hartſhorns, than ever I had ſeen their volatile ſalt make up: ſo that, unleſs we will merrily ſay, that the man, whoſe urine was diſtilled, had horns given him by his wife, we muſt acknowledge, that nature ſeems to give herſelf liberty to play in the configuration of volatile ſalts, and that caſualties have no unuſual influence on them; or, to ſpeak more properly, that the various degrees of fire, the differing copiouſneſs of the fumes, and many other intervening accidents, do keep thoſe configurations from being conſtantly regular. And I remember, that, a while ſince, filtering through cap-paper a tincture of glaſs of antimony, made with ſpirit of vinegar and ſpirit of wine, almoſt according to *Baſilius*; the matter, which remained in the paper (which was placed in a glaſs-funnel, and was of the ſame ſhape) did of it ſelf, when it began to grow dry, cleave into the figures of trees, whoſe trunks, greater boughs, and ſmaller branches, were, both for their ſhape and proportion, as lively repreſented as if they had been drawn by the curious pencil of ſome ſkilful painter: which paper I ſhewed to ſome perſons, that beheld it not without wonder, and, for aught I know, I am yet able to ſhew it you. Nor is this the only inſtance I could give you, if need were, if I had not trifled too long already to manifeſt at preſent, that now and then chance may make nature ſeem to emulate art.

That bucks-horns may be ſubſtituted for ſtags-horns.

BUT as long as I have dwelt, *Pyrophilus*, on this ſubject, before I paſs to another, I muſt not forget to advertiſe you, that in caſe ſtags-horns cannot be procured for the preparation of the above-mentioned remedies, you may without much diſadvantage ſubſtitute bucks-horns in their ſtead: for almoſt all the trials we have had opportunity to make of the medicines we have been lately diſcourſing of, have been made with remedies, whereto bucks-horns afforded materials.

How to keep the ſpirit and ſalt of hartſhorn.

I HAD almoſt forgot, *Pyrophilus*, to tell you, that to keep the rectified ſpirit of hartſhorn, blood, or the like, is more uneaſy, than any thing but trial would make one think; and yet to keep the volatile ſalt is more difficult than to preſerve the ſpirit: for more than once, when I have kept theſe fugitive animal ſalts by themſelves, they have penetrated the corks, and ſcarce left me in the well ſtopped glaſſes any foot-ſteps of their having been there, and therefore thoſe chymiſts, that are not ſtrangers to theſe ſalts, have taken much pains to no great purpoſe, to keep them from avolation: ſome of the recenteſt and ingenioueſt are wont, that they may moderate their uncurbed wildneſs, to pour on them as much of ſome ſuch acid ſpirit, as that of ſalt of vitriol, *&c.* as will produce any manifeſt conflict with the volatile ſalt; never conſidering, that as this courſe doth indeed diveſt them of their fugacity, ſo it doth in effect diveſt them of a great part of their nature, and conſequently of their peculiar virtues. For I have elſewhere ſhewn, that the ſaline corpuſcles, obtainable by the fire from urine, being united with a ſufficient proportion of ſpirit of ſalt, will ceaſe to be what they were, and with the ſaline parts of the acid liquor, will make up a kind of ſal armoniack. But it is eaſier for me in this our caſe to ſhew, that another man's expedient is not good, than to ſubſtitute a good one; eſpecially in this place, where for ſome reaſons I muſt not ſet down the way, that I the beſt approve of: only I ſhall tell you, that my way long was (nor do I yet deſpiſe it) to preſerve volatile ſalts in their own rectified ſpirit, which ſwimming over them, kept them from the immediate contact of the air, and preſerved them ſo well, that by this means I have ſecured even ſmall parcels of the fugitive ſalt of human blood for many years.

[*BUT ſince the ſpirit and ſalt even of this ſort of horns will not, I fear, be found ſo eaſy for every man, eſpecially, if he be a novice in chymiſtry, to procure in any conſiderable quantity; and ſince the declared intent of my communicating to the reader my obſervations about theſe ſpirits of hartſhorn, blood,* &c. *was to furniſh him with ſuch chymical remedies, that men may by their eaſineſs and cheapneſs be invited to provide them, for the uſe of the poor; I preſume it will not be improper to preſent him with a* ſuccedaneum *or two, that may be eaſily enough obtained from ſal-armoniack, though theſe preparations have ſuch connexion with divers other paſſages, wherewith they were written to the perſon I here call* Pyrophilus, *that, to avoid the too much diſmembring thoſe papers, and to make theſe proceſſes the better underſtood, I muſt content my ſelf to leave out thoſe particulars, that can beſt be ſpared; hoping, that the reſt will be eaſily excuſed, at leaſt by thoſe, who know, how much ſome chymiſts themſelves have been deluded in their trials of the divulged proceſſes, divers of which are either falſe or very uncertain, and others, though they ſhould ſucceed, would give but a ſophiſtical ſpirit, much of the obtained liquor coming from the diſtillable concretes, that muſt, according to ſuch proceſſes, be mingled with the ſal-armoniack, of which I could eaſily give inſtances, even out of modern and applauded writers.*]

Of the ſpirit of ſal armoniack, and divers attempts and ways of preparing it.

THE ſpirit of ſal armoniack, *Tyrophilus*, hath ſuch wonders aſcribed to it by chymiſts, that, if I ſhould conclude theſe papers touching ſpirits of an urinous nature, without ſaying ſomething to you of that, you might think I had left the conſiderableſt of them unmentioned; but as I the rather acquaint you with the little I know of it, becauſe, though I have met with divers authors, that extol it, I have ſcarce met with any, that teaches intelligibly, and candidly, how to prepare it, which perhaps moſt of them did not know themſelves; ſo I hope you will exact an accurate account of it the leſs rigidly, becauſe I can preſent to you but little on that ſubject, beſides the few obſervations, wherewith my own curioſity has ſupplied me; having ſcarce ever (to my knowledge) ſeen any ſpirit of ſal armoniack, ſave what my own furnaces have afforded me. And therefore without preſuming to ſet down ſolemn proceſſes about a ſubject, wherein I have found a ſmall variation of circumſtances hinder the operations made on it from producing uniform effects, I ſhall content myſelf to give you as true an information, as my memory will afford me, of a few of my proceedings with this nice ſalt, and the ſucceſſes of them: only premiſing, in a word, that by ſal armoniack I here mean the factitious and venal, conſiſting of urine, ſoot, and ſea-ſalt.

AND firſt, according to the way propoſed by *Glauber* (in the ſecond part of his philoſophical furnaces) we diſtilled it out of an open retort (with a cover to clap on and take off, as occaſion requires) with a mixture of *lapis calaminaris*; and once we, that way, obtained a quantity of liquor, which ſeemed exceeding ſtrong: but before we could make any trials with it, the phial that contained it having been accidentally broken, we loſt the opportunity of ſatisfying ourſelves of the efficacy of it. And having not long ſince attempted to make ſuch a ſpirit the ſame way, there came over indeed a liquor, which ſeemed to be the ſpirit of ſal armoniack; but when we came to rectify it in a gentle heat, the greater part of it, to our wonder, coagulated in the retort, whereinto it was put to be diſtilled, into a perfect ſal armoniack, (a pretty quantity of which I keep by me) and thereby betrayed the above mentioned liquor, to have been little elſe than the ſal armoniack itſelf, forced over by the violence of the fire, without having ſuffered any ſeparation of its ingredients. Nor is it by us alone, that the proceſs ſet down by *Glauber* hath been unproſperouſly attempted; and yet perhaps it might have conſtantly enough ſucceeded with him, and the difference of the *lapis calaminaris* (in which we have obſerved much diſparity, according to the places it comes from) may have produced the complained of variety of ſucceſſes.

WE alſo attempted to diſtil a ſpirit from ſal armoniack (to pretermit divers other trials) by mixing it with equal parts of ſalt of tartar; but in this experiment we met with variety of ſucceſs: for having exquiſitely incorporated the two ſalts by the help of a little fair water, we have divers times had the upper part of the receiver (carefully luted on to a ſomewhat large retort) all candied over on the inſide with volatile ſalts of ſeveral ſhapes; and the liquor afterwards forced over hath ſometimes remained long enough in the form of a very ſubtile and penetrant ſpirit; and ſometimes again it hath in the very receiver almoſt totally coagulated it ſelf into a lump of cryſtalline ſalt: and when we had mixt the ſalt of tartar, and ſal armoniack, without any water or other moiſture at all, our ſucceſſes have been very like thoſe above mentioned. Upon this occaſion I dare not omit acquainting you with an experiment, which yet I learnt not upon this occaſion. Take of pure ſalt of tartar, and of good ſal armoniack, equal parts (let them be both very dry, or elſe you may loſe your labour) and grind them very accurately together, though you be deterred from continuing that toil, by a very ſubtile and fetid urinous ſteam, wont to exhale from the mixture: theſe ſalts being thus exquiſitely incorporated, you muſt put them into a large glaſs retort, to which you may fit a receiver to catch a fetid liquor, that ſometimes we have obſerved to come over. Then adminiſtring by degrees a very ſtrong fire, the top and neck of the retort will be lined with a pure white ſublimate, which ſeems to partake as well (though nothing near ſo much) of the ſalt of tartar, as of the ſal armoniack and of its qualities, and yet to differ from either. And though this ſublimate be far enough from being the true volatile ſalt of tartar, ſo highly extolled by *Paracelſus* and *Helmont*; yet it is no ignoble medicine in obſtructions, and ſome other diſtempers: and I remember one of the moſt expert chymiſts I know, having made trial of ſome I preſented him, told me he found ſuch effects of it, as made him divers times very preſſing and ſollicitous for more. The fetid liquor, that will come over, we have found ſometimes to be very little, and at other times much more copious, without being able to diſcern clearly, whence the diſparity proceeded; and the caput mortuum remaining in the retort, by ſolution, filtration, and coagulation, affords a pure ſalt of greater diuretical efficacy, than almoſt any I have hitherto met withal. Another way, by which we attempted to attain a ſpirit of ſal armoniack, was, by accurately mixing two parts of it with three or four of quick-lime, whoſe virtue had not been impaired by being expoſed to the air. This mixture being diſtilled in a retort, placed in ſand, with a ſtrong fire afforded us (together with ſome dry ſublimate in the neck of the retort, and, as I remember, a little volatile ſalt in the receiver) a very ſtrong and yellowiſh ſpirit, ſo exceedingly penetrant, and ſtinking, that it was not eaſy to hold one's noſe to the open mouth of the phial, wherein it was kept, without danger of being ſtruck down, or for a while diſabled to take breath, by the plenty and violence of the exhaling ſpirits. But the liquor forced over by this method, though exceeding vigorous as to its qualities, was inconſiderable as to its quantity; and therefore we now chuſe to vary a little this way of proceeding, and let the quick-lime lie abroad in the open air (but protected from all other moiſture, except that of the air) for divers days: in which time the imbibed humidity of the ambient air would in ſome degrees ſlake it, and make it ſomewhat brittler than it was before: and the lime thus prepared, being mingled with ſalt armoniack, and diſtilled in all circumſtances after the former manner, afforded us a liquor ſo copious, and yet ſo ſtrong, that we hitherto acquieſce in this way of diſtilling this wild ſalt, as the beſt we have yet met with. But note, that we uſed, towards the latter end, to increaſe the fire to that degree, by heaping up coals on the upper part of the retort, that the mixture in the retort hath been brought to flow. Note alſo, that though even the ſpirit thus drawn perſevered long in the form of a liquor, yet yeſterday coming to look upon a phial of it, which we reſerved, to try what effect time would have on it, we found, that about a fourth or fifth part of it had ſpontaneouſly coagulated it ſelf into exactly figured grains of a cryſtalline ſalt, the liquor ſwimming about it; retaining, nevertheleſs, a very ſtrange ſubtlety: which obſervation, concording with divers others, makes me apt to doubt, whether or no this ſo celebrated ſpirit of ſalt armoniack be really much, if at all, other than the reſolved ſalt of urine, and ſoot, of which that body conſiſts, ſomewhat ſubtiliated by the fire, and freed from the clogging ſociety of the ſea-ſalt, to which they were formerly aſſociated and united; though I confeſs it ſeemeth not improbable, by the great energy, which may be obſerved in this ſpirit, when it is dextrouſly drawn, that the entire concrete, and the quick-lime, may afford it ſomething, that it could not receive from either of the ingredients, whence the mixture did reſult, as we ſee in aqua regis, which diſſolves crude gold, though neither the ſalt armoniack, nor the petre, nor the vitriol alone affords, by the uſual ways, ſpirit capable of producing that effect. The great virtues, and uſes of ſalt armoniack, eſpecially in phyſick, I cannot now ſtay to treat of, but you will find them largely enough ſet down by *Glauber*; whoſe encomiums nevertheleſs muſt not be all adopted by me, who in this place mention the ſpirit of ſal armoniack but as a medicine, that is near of kin, and may ſerve for a ſuccedaneum to the ſpirits of hartſhorn, urine, blood, *&c.*

BUT although the laſt mentioned way, *Pyrophilus*, be the leaſt imperfect one we have hitherto met with, of diſtilling ſalt armoniack; yet becauſe you may ſometimes need a ſpirituous liquor impregnated with the activeſt parts of that noble concrete, when you want either retorts to diſtil in, or furnaces capable of giving ſtrong fires, I dare not omit to inform you, that we have ſometimes drawn over ſuch a liquor of ſalt armoniack after the following manner: Diſſolve pure ſalt armoniack in a ſmall quantity of fair water; then in a cucurbit put ſuch a quantity of ſtrong quick-lime powdered as may fill up a fifth or ſixth part of the veſſel, and water it very well by degrees with the former ſolution of the ſalt armoniack, and immediately clap an alembick on the cucurbit, and faſten a receiver to the alembick, cloſing the joints very accurately; and from this mixture, by the gentle heat of a bath or a lamp, you may obtain a liquor, that ſmells much like ſpirit of urine, and ſeems to be much of the ſame nature: and this volatile liquor being once or twice rectified *per ſe*, with a very mild heat grows exceeding fugitive and penetrant, and works by ſweat, and a little, perhaps, by urine. And I remember, that when I firſt made it, having been induced by ſome analogical experiments, I had formerly made, to give it to one, that had a patient troubled with an extremely violent cough, I had an account quickly brought me, that he not ſlowly, but wonderfully mended upon the very firſt or ſecond doſe; and indeed the trials, that have hitherto been made of it, make me hope, that it will prove little inferiour in efficacy to the other above mentioned more coſtly ſpirits, ſcarce any of which being preparable by ſo ſafe and compendious a way, if this medicine emulate them in virtue, the eaſineſs of the preparation (wherein little time needs be ſpent, and leſs danger of breaking veſſels incurred) will much endear it to me. But, *Pyrophilus*, becauſe I would aſſiſt you to make variety of experiments about volatile ſalts, and becauſe divers trials may be more conveniently made, when the ſaline corpuſcles are in a dry form, than when they are in that of a liquor; I will take this occaſion to mention to you a way, by whoſe intervention a change on the fixed body employed about the newly mentioned experiment, hath ſometimes afforded me ſtore of volatile ſalt. This way was only to mingle exquiſitely a quantity of ſal armoniack, with about thrice its weight of ſtrong wood-aſhes. For the ſpirit, that we this way draw out of a retort placed in ſand, did quickly in the receiver coagulate into a ſalt; and this method was again experimented with like ſucceſs. And the ſalt thus made we found ſo extremely ſubtile and volatile, that it ſeemed to be much of the ſame nature with that of urine; and if it be indeed (as probably it is) only the volatile ſalt of the urine, and perhaps alſo of the ſoot, whereof the ſal armoniack conſiſts, this may paſs for a more compendious way of obtaining ſuch ſalts, than others, that are hitherto wont to be practiſed among chymiſts. But I will not undertake, that this way of obtaining rather ſalt than ſpirit ſhall conſtantly ſucceed. Yet if you find it do not, I ſhall not perchance refuſe you a better way. But if you could deviſe a method (which poſſibly is not unattainable) of bringing over into a ſpirit, not the bare urinous and fuliginous ingredients of ſal armoniack, but the whole body; it may be, you would have a menſtruum, that would make good, if not ſurpaſs even *Renanus*'s and *Glauber*'s elogies of the ſpirit of ſal armoniack.

**Of preparations of ſaline and ſulphureous fetid liquors.**

THE affinity betwixt volatile ſalts and ſulphurs doth, *Pyrophilus*, as well as your curioſity, invite me to acquaint you with ſome of the trials we have made about the preparation of ſulphureous fetid liquors; which I am the more inclined to do, becauſe, though I find mention made of ſome of them in chymical books, yet they are there delivered with ſo little encouragement, amongſt many other proceſſes, of which it appears not, that the preſcribers made trial, that when I had diſtilled ſome of thoſe ſulphurs, divers expert chymiſts were very deſirous to have a ſight of them, to ſatisfy themſelves, that ſuch liquors could be ſo prepared. The way of making the common balſam, or ruby of ſulphur, is too well known to need to be long inſiſted on. Only, becauſe there is ſome little variety by ſeveral in the preparation, it will not perhaps be amiſs to inform you, that we are wont to make it by mixing about three parts of oil of turpentine, with two of good flour of brimſtone, and ſetting them on a ſtrong urinal ſlightly ſtopped in an heat of ſand, only great enough to make the liquor with a little crackling noiſe (whenceſoever that proceeds) work upon the ſulphur, till it be all perfectly reſolved into a blood-red balſam, which will be performed in ſix, eight or ten hours, according to the quantity of the ingredient to be united. This balſam, which is indeed in ſome caſes no deſpicable remedy, is by vulgar chymiſts according to their cuſtom, very highly extolled, and ſometimes employed in diſtempers and conſtitutions, wherein, inſtead of performing the wonders by them expected, its heat doth more harm, than its drying and balſamick properties, do good: but yet apparent it will be, by what we ſhall ſay anon, that by this preparation the body of the ſulphur is ſomewhat opened, and therefore (as we ſaid) in ſome caſes the ruby of ſulphur may prove no ineffectual remedy; which may probably be improved, if it be prepared by bare digeſtion in a very gentle heat, by which courſe we have proſperouſly prepared it, though not in ſo ſhort a time, when we made it not in order to ſome other medicine.

**The way of making the common balſam, or ruby of ſulphur.**

To volatilize the balſam of ſulphur.

To volatilize the ſulphur thus reſolved, we took the balſam made the former way, in a few hours; and putting it in a retort, either with, or without fair water, which is ſuppoſed to help to carry up the ſuperfluous oil, we placed the veſſel in a ſand-furnace; and, with a gentle heat drawing off as much of the oil of turpentine, as would in that heat come over, we ſhifted the receiver, and carefully luted on the new one; and laſtly, giving fire by degrees, we forced over a liquor of a deep and darkiſh red, extremely penetrant, but of a ſmell ſo ſulphureous and diffuſive of it ſelf, that it was ſcarce to be reſtrained by corks, and was by great odds ſtronger than that of the ruby before diſtillation.

The like experiment we tried in a glaſs-head and body placed in ſand, and through that way likewiſe we obtained a volatile balſam of ſulphur, yet we found it too inconvenient to be equalable with the former. What long digeſtions of this liquor will do, to take away, or leſſen its empyreumatical and offenſive odour, we have not yet been by experience ſatisfied, no more than of its medical virtues; though probably, the great penetrancy of the liquor conſidered, they will not be languid.

Authors alſo preſcribe the making a volatile balſam of ſulphur, by driving over, after the above-mentioned manner, a ſolution of flour of brimſtone in linſeed-oil, and this remedy they highly extol; but though it may probably prove a good medicine, yet ſince they commend it but by conjecture, and not upon experience, I ſee no great reaſon, why it ſhould be preferable to the other. For we find, that expreſſed oils are much more apt to receive an offenſive empyreuma, than oil of turpentine; which being much more volatile than they, requires nothing near ſo violent a heat to make it aſcend: and, unleſs it be found, that the ſulphureous particles are able to mitigate the corroſive ones, the diſtilled liquor of an expreſſed oil may prove noxious in the body. For by purpoſely (for trial's ſake) diſtilling oil-olive, by it ſelf, though not in a naked fire, we obtained a liquor of that exceeding ſharpneſs, that it would (taken inwardly) probably corrode, or fret either the ſtomach, or ſome other of the internal parts.

*Penotus* his preparation of a ſulphureous balſam, with the author's advertiſements upon it.

There is another way of preparing a ſulphureous balſam, to which *Penotus*, no ignoble chymiſt, aſcribes ſuch ſtupendous virtues, that though I have not yet made trial of it in diſeaſes, yet I dare not leave it altogether unmentioned; the proceſs being briefly but this: Take good balſam of ſulphur, made with ſpirit or oil of turpentine, and having freed it from its ſuperfluous oilineſs, pour on it well dephlegmed ſpirit of wine, and therewith draw, by affuſion of new ſpirit as often as need requires, a ſufficient quantity of a red tincture, which by filtration and abſtraction *in balneo* muſt be reduced to a balſamick conſiſtence. This liquor you may, if you pleaſe, by degrees of fire, drive through a retort placed in ſand, and thereby obtain a volatile balſam of very great penetrancy, and probably of no ſmall efficacy: but the trial I have made of this proceſs, gives me occaſion to advertiſe you;

1. That, unleſs your balſam be reduced to a ſtiff thickneſs, and almoſt to drineſs it ſelf, the operation will hardly ſucceed; we having fruitleſly digeſted for ſome months ſpirit of wine upon balſam, whoſe conſiſtence was ſomewhat too liquid.

2. That as ſoon as the ſpirit of wine is ſufficiently tincted, it ought to be decanted, and ſucceeded by new; leſt by too long digeſtion, inſtead of heightening its tincture, it let fall that, which it hath already acquired.

3. That upon a very ſlow abſtraction of moſt of the tincted ſpirit in a digeſting-furnace, we once found the remaining liquor not to be in the form of balſam, but to conſiſt partly of ſpirit of wine, and partly of a ſeeming diſtinct oil, whereinto the ſulphureous tincture was reduced. The balſam of ſulphur thus made without diſtillation ſeems likely to be an innocenter and nobler medicine, than the common ruby of

ſulphur, made with a hot and ill ſcented oil of turpentine: and by this preparation may alſo appear the truth of what we formerly ſaid, when we told you, that the body of the ſulphur was opened by ſolution in oleaginous liquors: for out of the common thickened balſam, as you may be informed by this proceſs, well rectified ſpirit of wine will, in a ſhort time, extract a blood-red tincture; whereas by long digeſtion of ſpirit of wine alone upon pure, but undiſſolved, flowers of brimſtone, we could not diſcern any change of colour in the menſtruum; though I dare not deny the poſſibility of what ſome authors affirm, who write, that ſpirit of wine very excellently dephlegmed will in time, of it ſelf, draw a tincture from flowers of ſulphur, which tincture they yet pretend not to make of a higher than a lemon-colour. And, by the way, let me tell you, that our red tincture formerly mentioned is (if it be well made) ſo ſtrong of the ſulphur, that probably it would make a very penetrant, and effectual outward remedy in aches, and divers other cold diſtempers of the nervous parts; for it hath been already found, that good ſpirit of wine alone is one of the powerfulleſt fomentations in divers caſes of that nature, (inſomuch that it hath been ſometimes found to arreſt the ſpreading mortification of gangrenes;) and therefore being ſo richly impregnated with ſulphur, which is, even without the aſſiſtance of ſo ſubtile a vehicle, very available in many diſaffections of the *genus nervoſum*, it is probable, that the ſkilful aſſociation of two ſuch active remedies may produce conſiderable effects.

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Of an excellent balſam of ſulphur, made only with oil-olive. The common way of preparing it.

TAKE of pure flowers of ſulphur one part, of the beſt oil-olive four or five parts; mix them well together in a ſtrong earthen pot, able to contain a much greater quantity of the ingredients than is to be put in it; ſet this veſſel over a moderate fire of charcoals, throughly kindled, till the oil, though ſlowly, have perfectly diſſolved all the flowers of ſulphur, which will (if you work it well) be performed in about half an hour, or an hour, (according to the quantity of your materials:) but you muſt have a great care, during the whole operation, firſt, that the oil catch not fire, whereby it would not only be loſt it ſelf, but perhaps endanger the firing of the houſe; and next, that the mixture be kept nimbly and conſtantly ſtirring from the firſt beginning of the oil's action on the ſulphur, till the ſolution be fully made; and the pot (having been taken off the fire) be grown cold again. The chief ſigns, whereby you may perceive, that you have not erred in the operations, are, firſt, if the ſulphur be perfectly diſſolved in the oil, which you muſt often try, before you take it from the fire, by taking up with the tip of a ſtick, a drop or two of the liquor yet in preparation, and letting it cool on white paper, or on your nail, whereby you may diſcern, when the ſolution is perfectly made, by the deep redneſs, and tranſparency of the liquor, and by its containing no more in it any undiſſolved flowers of the brimſtone; next, by the conſiſtency of the balſam, which ought to be neither too liquid (as you will find it, if it hath not ſtaid its due time on the fire; nor too thick (as it is apt to become, if you remove it not ſeaſonably from the fire) but of the conſiſtence of ſomewhat thin honey: and laſtly, by the ſmell, which ought to be ſtrong of the ſulphur, but not of the fire; for though the ſulphureous ſtink is, in this remedy, to be expected, that empyreumatical one, which proceeds from burning (and by ſkilful noſtrils may be eaſily diſcerned) is very poſſible to be avoided.

THE doſe of this balſam, when it is to be inwardly uſed, may be from two to fifteen, or twenty drops, according as the greatneſs of the diſtemper, and chiefly the ſtrength and conſtitution of the patient ſhall require and bear. It may be given upon a faſting ſtomach, either alone, or brought to the conſiſtence of pills, or of a bolus, with powdered ſugar, liquorice, *&c.* or elſe diſſolved in any convenient vehicle; wherewith its oleaginous nature will permit it to mingle. Outwardly it may be adminiſtred either by bare inunction of the part affected, or elſe by incorporating it with any other convenient ointment, or plaiſter: after which, we are wont to preſcribe to have an application made to the part of two or three little bags filled with ſand, as warm as the patient can eaſily endure it, and ſhifted as ſoon as either of them begins to cool, that by this means, the pores being opened, the virtue of the balſam, by being made more penetrant, may reach the farther.

**Other ways of preparing this balſam.**

I HAVE been thus particular, *Pyrophilus*, in the mention of this remedy, becauſe though it ſeem but a ſlight and trivial preparation, yet experience hath given us a better opinion of it, than I fear the ſlightneſs of the preparation will as yet allow you; and indeed its virtues I am apt to think more than I have yet had occaſion to obſerve: and therefore muſt refer you to *Rulandus* his centuries, where they are often mentioned. But outwardly in ſtrains, old aches, bruiſes, and the like, it is wont to be very effectual; in the beginning of fits of the gout it hath ſeveral times (though not conſtantly) been proſperouſly applied both to Mr. *B. B.* and divers other perſons, and ſometimes it hath been found not ineffectual even in the ſciatica itſelf. And as for paralytical diſtempers, I have had by a ſkilful phyſician an account ſent me of ſcarce credible things, which it hath therein performed: to which I ſhall only add, that a while ſince I had great thanks returned me on the behalf of a fair young lady, to whom I proſperouſly preſcribed it againſt a great tumour in her neck, which was ſuppoſed to be the beginning of the king's-evil: but this tumour was recent enough, which circumſtance I think fit to ſpecify, becauſe I fear, that if the ſcrophulous tumour had been inveterate, the ſucceſs would not have been ſo good. Inwardly the chief uſe we made of it hath been in coughs, and diſtempers allied thereunto; but its balſamick nature, making it both healing and reſiſtive (if I may ſo ſpeak) of putrifaction, makes it probable, that its virtues may be more extenſive: to which purpoſe I remember, that a while ſince a friend of mine tried it with wonderful ſucceſs *in mictu ſanguinis ferè deplorato*, having firſt by a gentle heat reduced it to ſuch a conſiſtence, as allowed him to make it up into pills. But of the particular caſes, wherein our remedy hath been ſucceſsful, no more at preſent; we ſhall rather ſubjoin, that though this have been the way, which we have the ofteneſt imployed in the making of the balſam, yet we muſt not conceal from you, that we have divers times met with accidents, which fruſtrated our endeavours and expectations. For if the fire adminiſtred be too languid, the ſolution of the ſulphur by the oil proceeds not well: and on the other ſide we have found, that not only a ſtrong heat is apt to burn the matter, or to make the oil boil over, and perhaps take fire; but even that upon a very little exceſs in the degree of heat, the oil and ſulphur would, before it could be expected, degenerate together into a heavy and viſcous lump, (almoſt of the colour of the liver of an animal; which coagulated matter proved afterwards exceeding difficult to be by the affuſion of freſh oil diſſolved, and reduced to a due conſiſtence. Wherefore we tried to prepare this balſam, by putting the proportion of ingredients formerly mentioned into a ſtrong urinal, which we placed in ſand, and making under it no more fire than was ſufficient to make it ſlowly work upon the flowers, (which did often during their ſolution make a crackling noiſe;) we continued the operation for divers (perhaps many) hours, at the end of which, we found the ſulphur diſſolved, and the mixture reduced to a balſamick colour and conſiſtence. So that if you diſtruſt your dexterity to prepare this balſam by the former way with a naked fire, we muſt adviſe you to make uſe of this latter way, as that, which is the ſafer, though it be the longer way of proceeding. Nay, when we had leiſure enough, we did for trial's ſake, proſperouſly attempt the ſolution of flowers of brimſtone, with common oil, by the far gentler heat of bare digeſtion, and by that means obtained a balſam perfectly free from aduſtion, but of ſomewhat too liquid a conſiſtence; which may be eaſily remedied by the mixture of powdered liquorice, ſugar, or any other ſuch convenient concrete. We muſt alſo advertiſe you, that this balſam may alſo be prepared with oil of nuts, of poppy-ſeeds, of hypericon, inſtead of oil-olive, or any other expreſſed oil, appropriated to the particular diſtemper, againſt which the phyſician intends to employ the remedy: only care muſt be had, that the ſpecifick qualities of the oil be not ſo fugitive, as to be deſtroyed by the ebullition requiſite to the making of the balſam; which if it be to be enriched with ſpecifick virtues in relation to any particular diſeaſe, may perhaps be beſt prepared by the laſt mentioned way (of digeſtion) wherein the ſubtile ſpirits, that impregnate the oil, are not in ſuch danger to be diſſipated by the fire.

A balſam of antimony.

THE knowing chymiſts themſelves, *Pyrophilus*, are wont ſo much (and perhaps not altogether undeſervedly) to extol the efficacy of antimony, that we were thereby invited, beſides divers preparations of it for internal uſe, to attempt the making of ſome remedies of it, that might alſo be externally applicable; and in proſecution of this deſign, we found, that by boiling four or five fingers height of good oil of turpentine upon very finely powdered antimony, put with the liquor into a ſtrong glaſs urinal, placed in ſand, the oil after ſome hours would grow exceeding high tincted; and being gently in great part abſtracted, would leave behind it a body of a balſamick conſiſtence, and a deep redneſs: which may, I preſume, be applied to reſolve, and diſcuſs hard tumours, and remedy divers other outward evils, with more effect, than the ſimple balſam of common ſulphur formerly deſcribed. And from this antimonial balſam abſtracted to a ſtiffer conſiſtence, we found, that ſpirit of wine would draw a tincture, which I likewiſe ſuppoſe might prove a very powerful fomentation; though the ſpirit we uſed (perhaps becauſe it was not ſufficiently dephlegmated) did not in a few days attain to more than a very pale redneſs: but this tincture being ſlowly freed from the moſt part of the ſpirit of wine, became of the conſiſtence of ſomewhat liquid honey, and of a deeper colour, thereby affording us a purer balſam; which we have not yet, (being hindred by ſome accidents) attempted to bring over the helm. Nor did we here deſiſt, but by divers trials found, that the antimonial balſam, above mentioned, being put into a retort, placed in ſand, and preſſed by degrees of fire, would at length emit ſteams, which would condenſe in the neck of the retort, and fall thence into the receiver in ſanguine drops. This volatile red balſam (eſpecially if by this volatilization the antimony have loſt its emetick property) we cannot but think endowed with more than ordinary virtues, outward and perhaps inward too; conſidering the great penetrancy of the liquor, and the energy of the mineral, with whoſe ſubtle parts it is richly impregnated, if it conſiſt not mainly of them. But we are yet in proſecution of this preparation, and therefore till we have ſeen, how far we are like to improve this remedy, we ſhall forbear any farther mention of it; eſpecially ſince we have already, in this very paper, given you, as we ſuppoſe, ſufficient proof, that we are more ſollicitous for your ſatisfaction and proficiency, than for our own reputation, (of being a ſevere critick in eſtimating of medicines) for otherwiſe we ſhould not have been ſo indiſcreet, as to acquaint you with any preparation, of whoſe medical virtues we have not yet made much trial, whilſt we are not deſtitute of other remedies, whoſe efficacy hath been manifeſted to us by experience. But we have often obſerved, that divers uſeful chymical preparations are mentioned ſo obſcurely, and unintelligibly, by the authors that write of them, or elſe are without any particular, or encouraging note of diſtinction mentioned

Of the obſcure and cryptical way of writing of chymiſts.

amongſt a croud of other proceſſes; ſome of which have perhaps already been found to be falſe, or trivial, and others of which may be rationally enough diſtruſted, that moſt phyſicians, and chymiſts themſelves, are deterred from attempting to prepare thoſe remedies; not ſo much becauſe they ſeem unlikely to prove conſiderable, as becauſe they are afraid, that the proceſſes are falſe, or fraudulently ſet down; and conſequently, that concretes of ſuch a conſiſtence, colour, ſcent, and other obvious qualities, as are aſcribed to the remedies propoſed, are not preparable by the publiſhed directions.

AND that you might ſee, *Pyrophilus*, what diſcouragements I have met with even from artiſts themſelves, to keep me from truſting to printed chymical proceſſes, I think it not amiſs to mention here a memorable paſſage of the famous and experienced *Alexander Van Suchten*, who is reported to have gotten more by the practice of chymical phyſick than any of the contemporary profeſſors of it: for he, towards the end of his book of the ſecrets of antimony (of which he clearly diſcloſeth not any in that treatiſe) gives this account of his cryptical way of writing: *Quod in hoc tractatu nullum* recipe *propoſuerim, ob id factum eſt, quod vos ſeducere nolo*; recipe *enim illa ſeducunt juniores medicos: ſed neque à* Theophraſto *ullum* recipe *ſcriptum eſt, quod ad medicinam, quin occultum ſenſum habeat, & in quo nihil vel deerit, vel abundet, & hoc non ſit ſine magnis cauſis.* Wherefore I make account, that, beſides that ſuch changes of the qualities of bodies may afford much light to naturaliſts, he doth chymiſts no uſeleſs piece of ſervice, that acquaints them with the ſucceſs of the nobler ſort of proceſſes mentioned in authors, though he ſhould give them little or no account of the virtues of the remedies prepared by thoſe proceſſes. But this I hope is not altogether our caſe: for beſides that our obſervations are likely to ſave you much trouble, and perhaps ſome miſtakes, and miſadventures; beſides that, (I ſay) we have had opportunity to obſerve ſuch eminent effects of ſeveral of the volatile liquors deſcribed in theſe papers, as may juſtly give us promiſing expectations of the properties of the reſt, which are in their obvious qualities ſo near of kin to them. And this ſort of medicines having been found ſometimes to do wonders, and generally to be ſafe, (which of a few of the known operative, and not ſpecifick medicines, can be truly affirmed) I am apt to think, that he, that ſhall bring theſe remedies, in ſpite of their ill ſcent, into the good opinion of phyſicians, may make no inconſiderable number of patients beholden to him.

I SHOULD not, *Pyrophilus*, proceed to make you repent your curioſity to know my thoughts of the urinous, and ſulphureous remedies it hath hitherto made me treat of; were it not, that there yet remains ſomething to be ſaid, without which, all that hath been ſaid, will ſcarce ſignify very much towards the effectual recommending of thoſe medicines to your eſteem and practice.

Concerning the empyreuma of chymical extracts, and their offenſiveneſs, compared with the Galenical, and thoſe which are commonly uſed by the methodiſts.

FOR, I do not ignore, *Pyrophilus*, that not only the generality of the Galenical phyſicians, but divers of the more eminent and judicious of the chymiſts themſelves, have been pleaſed to condemn the internal uſe of liquors, driven through a retort by the violence of fire, upon the ſcore of their being offenſively empyreumatical, and ſtinking: among which ſorts of liquors I cannot expect, that our ſpirits of blood, hartſhorn, *&c.* will eſcape the being reckoned. But foraſmuch as the proſperous effects I have had opportunity to ſee, of divers remedies of that nature, have given me for them rather an eſteem, than either a deteſtation or contempt; I ſuppoſe it may prove no unſeaſonable piece of juſtice to the ſpirit of blood, and the other noble, though fetid remedies I have been ſetting you down; nor no unſerviceable piece of charity to men, if in this place, and once for all, I ſpend ſome lines in endeavouring to reſcue theſe criminated medicines from the great prejudice they ſuffer under, and from a reputation, which whilſt it renders them more odious than even their ſmell can do, is likely to make men deny themſelves the benefit of them.

And whether the offenſiveneſs of divers chymical medicines proceed from the violence of the fire, or the nature of the matter.

I MIGHT here on this occaſion call in queſtion whether not only Galeniſts, but even many chymiſts themſelves, be not ſomewhat more afraid than they need be, of what they call *Empyreuma*. But I will ſuſpend a while that queſtion, and at preſent confeſs to you, that I have ſometimes doubted whether or no that ſtink, which is generally called by the newly mentioned name, do always and neceſſarily proceed from the impreſſions of a violent fire. For to make a pure ſpirit, and ſalt of urine, there needs nothing, but to let it in a well-ſtopt veſſel putrify for a competent time (as we elſewhere teach) in a dunghil, or any reſembling warmth, (and that it ſelf, perhaps, is not neceſſary to its putrifaction) and then to draw off an eighth or tenth part of the liquor, that firſt aſcends by the gentle heat of a bath: by which, or by the yet milder warmth of a lamp-furnace, it may be ſufficiently rectified, and brought to yield, beſides the ſpirit, good ſtore of ſalt. And ſince the ſpirit thus made differs ſo little in ſmell or taſte from thoſe of blood and hartſhorn, that moſt men's noſes are not critical enough to diſtinguiſh them, (and we have ſometimes taken pleaſure to make chymiſts themſelves to miſtake the one of thoſe liquors for the other) it ſeems worth conſidering, whether or no the fetid and urinous taſte and ſmell, which in theſe ſpirits is ſaid to be empyreumatical, and to proceed from the aduſtion of the fire, be not the genuine taſte and odour of the ſpirituous and ſaline particles of the mixed bodies themſelves, which they would manifeſt, if they were copiouſly extricated (to ſpeak in the king's language) ſeparated from the other principles or ingredients, and aſſociated into one body, though without the violence of the fire. For to diſtil the ſpirit of putrified urine, wherein the like ſmell and taſte are eminent, there needs (as we ſaid) no greater heat than that of a lamp-furnace, or of horſe-dung, (ſince in the latter of theſe only, urine too long kept, and but negligently ſtopt, hath been obſerved to have loſt its volatile ſalt and ſpirit, before it was taken out of the horſe-dung. And ſuch a heat ſeems not great enough to impreſs an empyreuma upon ſuch a liquor: for we ſee, that moſt things diſtilled in the greater heat of a bath, are commended by phyſicians and chymiſts for their being free from empyreuma. And what activity may be acquired by the ſubtle parts of a mixed body, by the convening (if I may ſo ſpeak) of ſuch ſpirituous particles, diſengaged from thoſe other parts, which clogged or impriſoned them, without any empyreumatical impreſſion from any violent or external heat, may appear by the chymical oils of ſpices. For though they be uſually drawn by chymiſts and apothecaries, by the help of water in limbecks; and though they have by us been drawn after another manner, (which we may elſewhere teach you) with a much gentler heat (ſometimes not exceeding that of an ordinary balneum) yet theſe well-dephlegmed liquors retaining ſo well the genuine taſte and ſmell of the concretes they were drawn from, that they paſs unaccuſed of empyreuma, are ſome of them much ſtronger and hotter than the ſpirit or ſalt of man's blood, or hartſhorn. As may appear eſpecially by the oil of cinnamon, which if pure, is more penetrant and fretting, than any thing but trial could eaſily have perſuaded me. And leſt you ſhould object, that the fire doth conſiderably contribute to the ſtrength of theſe liquors, otherwiſe than by diſengaging the particles they conſiſt of from the unactive parts of the concrete, and aſſembling them together: I muſt advertiſe you, that I have obſerved little leſs heat and penetrancy, than in divers of theſe, in ſome liquors ſeparated without the aſſiſtance of diſtillation: as for inſtance, in the purer ſort of the true Peruvian balſam, and in another kind of natural balſam, almoſt of an amber colour, which belonged to an eaſtern prince (who carried it up and down with him as a jewel) whoſe domeſticks at his death ſold it, whereby I came to procure ſome of it, and found cauſe to wonder at its ſtrength both upon the tongue and in its operation. But granting, *Pyrophilus*, that the volatile remedies treated of in theſe papers may have their offenſive ſmell and taſte imputed to the fire, yet perhaps phyſicians would more ſlowly and more tenderly cenſure the remedies in queſtion for their empyreumatical ſtink, if they did but conſider, that they themſelves ſcruple not to uſe (to name thoſe among many others) ſenna and ſcammony, though the former be wont to gripe the guts, and the latter have an acrimony, heat, and mordacity ſo unkind to the bowels, that a few grains exceeded in the doſe turns it into poiſon; becauſe the ill qualities of theſe medicines may, by proper correctives, be ſomewhat mitigated; and the good they do, doth more than countervail the inconveniences, that attend the uſe of them. For the very ſame conſiderations, *Pyrophilus*, will be applicable to the excuſe of thoſe fetid medicines, for which we apologize. For though the empyreuma or impreſſion of the fire, for which they are rejected, be the quality, whoſe abſence from them were very deſireable; yet may that empyreuma by dextrous preparations be in ſome meaſure corrected, (inſomuch that I have known highly-rectified ſpirit of urine, by being digeſted for divers months in an exquiſitely ſtopt glaſs, brought to be of a ſcent, which to me ſeemed ſcarce at all ſtinking, and to others even pleaſant) and the prejudice, that may be juſtly feared from what remains, is advantagiouſly recompenſed by the benefits accruing from the efficacy of their more friendly endowments. And in effect we find, that the dogmatiſts themſelves are grown not to ſcruple the adminiſtring the ſpirit of ſalt, though extorted (if it be of the beſt) by a much greater ſtreſs of fire, than is requiſite to the diſtillation of any of the medicines we defend. And not only the famous *Riverius* (as we have elſewhere noted) extols the ſpirit of tartar, and ſoot, which are yet ſufficiently fetid and empyreumatical, but ſeveral other (and amongſt thoſe ſome of our eminent Engliſh) phyſicians frequently uſe, and commend the oil of guaiacum, forced through a retort. And no leſs do divers learned doctors eſteem, and employ the empyreumatical oil of amber; though (to note ſo much by the way) that be in divers caſes far inferiour to the volatile ſalt, which (if the fire be ſkilfully adminiſtred) may at the ſame time, and by the ſame operation, be obtained. This ſalt, beſides the efficacy aſcribed to it in the convulſions of children, having been lately found by experience to be an excellent medicine againſt the epilepſies, even of well-grown perſons, being adminiſtred in the doſe of not above a ſcruple or half a drachm, in a due quantity of piony-water, or ſome other proper vehicle.

And on this occaſion, you may alſo be pleaſed to take notice, that foliated gold is ordinarily and without ſcruple employed by phyſicians, not only to cover pills, but as a main ingredient (though how properly, I define not) of ſeveral of their richeſt cordial compoſitions extant in diſpenſatories; and yet to how great fire gold is wont to be expoſed before it be melted out of the ore (wherein it is uſually, at leaſt as far as we have obſerved, blended with other metals, and minerals) and to purify it upon the cupel, either with lead, or antimony, he, that is unacquainted with the operations of mineraliſts, and the art of refiners, will not eaſily imagine. And, *Pyrophilus*, to ſatisfy you yet farther, that the ſtrong impreſſion of fire in the medicines does not always make them ſo noxious, as they are commonly reputed; let me deſire you to take notice, that there is ſcarce any medicament more generally given, and applauded, even by methodical phyſicians, than ſteel, which is often adminiſtred in ſubſtance, made up with other ingredients, into the form either of pills, or electuaries. And yet we have wondered to ſee, what great fires, and violent blaſts of huge bellows, moved by water-engines, are uſed to melt iron firſt out of the ſtone; and if it be to be farther refined into ſteel (much of that uſed in phyſick being factitious) a new violence of the fire is requiſite. And though after all this, to make aſtringent *crocus per ſe* (which is accounted one of the beſt preparations of it) they are wont to keep *Mars* (as the chymiſts ſpeak) amidſt reverberated flames, or in ſome glaſs-man's furnace for many hours, yea ſometimes for divers days; yet this medicine is, with more ſucceſs than ſcruple, daily adminiſtered by learned phyſicians, in dyſenteries, fluxes, and other diſtempers, where aſtriction is required. And it is ſomewhat ſtrange to me, that the having been expoſed to no greater fire, than is requiſite to diſtil ſpirit of blood, or of hartſhorn, ſhould be much urged againſt thoſe medicines by thoſe, that ſcruple not to commend, and do almoſt daily, and oftentimes ſucceſsfully, preſcribe the lixiviate ſalts of plants, and particularly of wormwood, though theſe are not rightly made, but by the expoſing the concretes even to the violence of an incinerating fire. And as for the unpleaſantneſs of the ſmells of our ſpirits of blood, hartſhorn, *&c.* beſides that, to very many perſons there is no odour ſo loathſome, as that of a potion; we find, that the Galeniſts themſelves ſcruple not, in the fits of the mother, (which yet very rarely prove mortal) to repreſs (as men are wont to ſuppoſe) the unruly fumes by the ſmell of caſtoreum, aſſa fœtida, and even the empyreumatical odour of the burnt feathers of partridges: nor do they decline to uſe theſe homely, and ungrateful remedies to the patients of the tendereſt ſex, and higheſt quality; and indeed in dangerous caſes, I have known, fair ladies content to think it fitter to take down an ill-ſcented medicine, than venture the having their own bodies, in few days, reduced to worſe perfumes. And certainly we may juſtly ſay of health, as no leſs than an emperor ſaid, of the gain brought him by urine, that *it ſmells well, from what thing ſoever it comes.*

Ways of taking off the fetidneſs, from ſpirit of urine, hartſhorn, &c.

BUT, *Pyrophilus*, if your noſtrils were ſo nice, that they muſt needs be complied with, though with the hazard of impairing the virtue of the ſalts they are offended with, I could propoſe an effectual expedient to gratify them; and being now invited by ſo preſſing an occaſion, I ſhall not ſcruple to annex ſomething of it, and tell you, that if we may judge of the virtues of the ſpirit and ſalt of ſoot (which I am wont to make without addition) by their ſenſible qualities, they muſt be much of kin to thoſe of the ſpirit of hartſhorn, and of urine; (though theſe be animal ſubſtances.) And therefore having elſewhere more particularly, and by divers experiments, declared the affinity between theſe ſalts in divers regards; it will not, I preſume, be looked upon as an unuſeful or unſeaſonable hint, if I give you a ſummary, though but imperfect account, of what I remember my ſelf to have done, in order to the freeing of the volatile ſalt of ſoot, from that very offenſive ſmell, which may poſſibly make many, even of thoſe that need them, abominate thoſe medicines, how piercing and noble ſoever, which it blemiſheth. The proceſs is as followeth:

TAKE a quantity of a well-dephlegmed ſpirit of wine proportionate to the quantity of ſalt, whoſe odour you deſire to correct; into this ſpirit, drop as much oil of rhodium, or of any other odoriferous chymical oil, as will ſuffice to make the liquor as ſtrongly ſcented as you deſire it: ſhake the oil and ſpirit well together, and if they were both well made, the latter will imbibe the former, and ſometimes be thereby turned into a whitiſh ſubſtance; with which, if it ſmell not ſtrong enough of the oil, you may by agitation incorporate more oil; and if you judge the mixture too ſtrong already, you may dilute it at pleaſure, by the affuſion of more ſpirit of wine. This done, put the ſalt of ſoot into a bolt-head, or glaſs-egg, (according to the quantity, that you intend to ſublime) furniſhed with ſomewhat a long neck or ſtem, and afterwards pouring on leiſurely your odoriferous liquor, you may with it waſh down the ſalt, that is wont to ſtick in the neck of the glaſs. After this, you muſt very carefully ſtop the veſſel with a cork, and ſtore of hard wax, if you cannot conveniently make uſe of an exacter way of covering it. This glaſs you muſt place in a lamp-furnace, or ſome other, wherein you may give a very moderate heat, for that will ſuffice to elevate to the neck and upper part of the veſſel, the pure white ſalt of ſoot, imbued (at the ſecond time, if not at the firſt) with the ſcent of the odoriferous oil, which you imployed about the preparation.

THIS experiment, *Pyrophilus*, may prove of that uſe in phyſick, that it may deſerve as well for its nobleneſs, as the watchfulneſs, which is requiſite in him that makes it, to be illuſtrated by the enſuing

## OBSERVATIONS.

1. THEN it is requiſite, that the ſpirit of wine be very good. For that, which is not ſufficiently dephlegmed, will not readily and perfectly receive into it ſelf the odoriferous oil, wherewith it is to be performed. Nor would every chymical oil, although it were well ſcented, be fit for this preparation; for divers of them, as oil of turpentine, and oil of amber, will not ſufficiently mingle with ſpirit of wine, unleſs they be previouſly ſubtilized after a peculiar manner.

Obſervations concerning this method of taking off the empyreuma.

2. THE proportion betwixt the ſpirit of wine, and the oil that it is to be diſſolved in, it is not eaſy to determine; for a leſſer quantity will ſuffice of ſome oils, than of other. And the proportion of them muſt be varied, according as you would have the ſublimed ſalt to participate more or leſs of their odour, and other qualities.

3. GREAT diligence muſt be uſed in cloſing the top of the glaſs, becauſe of the great fugacity, and ſubtilty of the ſalt, whoſe avolation is to be prevented: but then much greater care is to be had, that the heat be not too ſtrong, but as equal as may be, and much inferiour to the moderate heat of an ordinary chymical balneum. For it is ſcarce credible, how eaſily this unruly ſalt will be excited either to make an eſcape at the mouth of the glaſs, or to break it in pieces. And I remember, among ſuch other accidents, which have befallen us in the preparation of this odoriferous ſalt, that having once ſet ſome of it to ſublime from a perfumed chymical oil, though we adminiſtered ſo gentle a heat, that we thought the veſſel out of all danger of being broken, or found open; yet in a ſhort time, the fugitive ſalt did with a great noiſe blow out the cork, that was waxed to the top of the veſſel, leaving in the bottom not a limpid oil, but a liquor of a red-colour, and a balſamick conſiſtence. But if the glaſs be wide enough to allow theſe fumes competent room, and if the heat be warily adminiſtered, the ſublimation may be well enough performed.

OF the medicinal quality of this aromatical ſalt, *Pyrophilus*, we have not yet had opportunity to make trial; but ſome eſteem may be made of them, by calling to mind the virtues of the ſimple ſalt of ſoot, and conſidering the nature of the liquors, from which in this our preparation it hath been ſublimed. The principal, if not the only thing, that ſeems to be feared, is, that the ſalt of ſoot being itſelf hot, and chymical oils being for the moſt part eminently ſo too, our ſalt may prove unfit for men of hot and cholerick complexions, and in ſuch diſtempers as proceed from exceſs of heat. But then it may conſidered in the firſt place, that the ſalt of ſoot, being of an extremely aperitive, reſolving, and volatile nature, and carrying up with it in ſublimation, only the more fugitive parts of the liquor, from which it is ſublimed; it is very likely, that the heat produced by a medicine, which by reaſon of its fugacity would ſtay but a very ſhort time in the body, will not be ſo laſting as that of ordinary ſudorificks, which are nevertheleſs often adminiſtered with good ſucceſs, even in hot diſeaſes.

Of the medicinal quality of theſe aromatized ſalts.

SECONDLY, That there are divers bodies and diſtempers, wherein remedies may be the more proper, for their being ſomewhat hot; and experience ſhews, that in dropſies (to mention no other diſeaſes) theſe volatile ſaline remedies, that ſet the blood a whirling, and powerfully promote its circulation, may prove very available.

THIRDLY, The heat, that may be feared upon the uſe of our ſalt, may be either prevented, or at leaſt moderated by the ſeaſonable uſe of ſuch cooling remedies, as may be no enemies to the operation of this ſalt, and yet no friends to the diſtemper, againſt which it is adminiſtered.

AND laſtly, ſuppoſing, that the inconveniences proceeding from this heat are not to be altogether avoided, yet the advantageous efficacy of ſo powerful and ſearching a remedy may very much outweigh that inconveniency: and therefore *Riverius*, as we formerly told you, commends the ſpirit of ſoot (though that ſeem at leaſt as hot as the ſalt) in pleuriſies; and in the ſame hot ſickneſs, we have, as we elſewhere relate, ſucceſsfully adminiſtered the ſpirit of hartſhorn, whoſe qualities are very near of kin to thoſe of ſalt of ſoot. Other inſtances of this nature you may meet with, diſperſed in other paſſages of my chymical papers: to which I muſt add, that upon the conſideration abovementioned, the methodiſts themſelves make no difficulty, in pills and other medicines, to uſe the chymical oil, either of cloves, or of nutmegs, or even of cinnamon. And ſome of our eminenteſt Engliſh doctors, as I lately noted, have not ſcrupled of late years to uſe the ſtrong and fetid chymical oils of amber and of guaiacum, (and the latter of theſe in large doſes) whereas in our preparation, only the fineſt and moſt aromatick parts of the oils ſeem to be aſſociated with the fuliginous ſalt, ſince the oil remaining after the ſublimation has been obſerved to be thick and ropy almoſt like a ſyrup.

BUT whether or no this aromatick ſalt be a ſafe medicine in all hot bodies and diſeaſes, it ſeems very probable, that it will prove a very powerful remedy in thoſe diſtempers, for which it is proper. For firſt, whereas Spagyriſts have, with much ſtudy, but without much ſucceſs, endeavoured to make oils capable of being mixed with other liquors, by depriving them of their oleaginous form, in which *Helmont* himſelf complains, that they are offenſive; we have, by our preparation, their fineſt parts aſſociated with the penetrant and volatile ſalt: by whoſe aſſiſtance they are not only fit to communicate their virtues to liquors, but aſſiſted to penetrate exceedingly; and perchance alſo, thereby to obtain ſuch an acceſs to the innermoſt parts of the body, as is ſeldom allowed to vegetable medicines. Secondly, we may have by this preparation one of the moſt noble and volatile ſalts of the world, not only freed from its ſtink, but imbued with the odour, and perhaps divers of the virtues, of what chymical oils we pleaſe. And ſince theſe chymical oils are by chymiſts and naturaliſts thought to contain the moſt noble and active parts of the vegetables, whence they have been diſtilled; and ſince alſo the ſalt of ſoot ſublimed from them carries up with it the fineſt parts of theſe oils, why may it not be hoped, that no ſmall number of diſtinct remedies may be afforded us by this ſingle experiment? Theſe remedies too may be the more acceptable both to phyſicians and patients, becauſe they have not in them any thing, that is mineral; and notwithſtanding their great penetrancy and efficacy, have in them nothing of corroſive, as many of the ſaline remedies preſcribed by phyſicians in their diſpenſatories. And thirdly, that the ſalt of ſoot thus ſublimed may be alſo enriched with the ſulphur or balſamick part of the ſpirit of wine, which was employed about its preparation, may appear probable enough to him, that ſhall examine, by his taſte and otherwiſe, ſuch rectified ſpirit of wine, as has had a ſufficient quantity of volatile ſalts ſublimed from it. And how balſamical a ſubſtance is diffuſed through pure ſpirit of wine, may be gueſſed at by the great change, which is made in the cauſtick ſalt of tartar, when it is ſo dulcified, as to make that excellent medicine, which *Helmont* extols againſt inward ulcers, and calls *Balſamus Samech*; which if one had the abſtruſe art of ſo preparing the ſalt and liquor, as to fit them for conjunction, might be made only by diſtilling very frequently pure ſpirit of wine from very fine ſalt of tartar. For by this means the fixed ſalt, retaining the ſulphureous ſalt or balſamick parts of the ſpirit of wine, (as may appear by the aquoſity of the liquor, that comes over the helm in this preparation) is thereby ſo deprived of its cauſtick taſte, that when it will rob no more ſpirit of wine, but ſuffer it to be drawn off as ſtrong as it was poured on, it will eaſily in a moiſt place run *per deliquium* into a liquor, not of a cauſtick, but balſamick (and, as it ſeemed to us, a pleaſant) taſte.

AND whereas, *Pyrophilus*, we have complained of the difficulty we have met with, to manage the unruly ſalt of ſoot, and keep it from breaking priſon, we muſt, to make this experiment be more practicable and uſeful, advertiſe you, that you may, if you pleaſe, inſtead of ſalt of ſoot, aromatize that of hartſhorn, or man's blood. And I might add, that a very ingenious friend of ours, Dr. *N. N.* has lately practiſed yet a more eaſy and preferable way of preparing medicines of this nature: but though I have partly tried his method, and found it to ſucceed well enough; yet ſince I had it but by communication from him, and that he makes a conſiderable advantage of it, I muſt forbear imparting it to you, till I ſhall have obtained his conſent to diſcloſe it.

I KNOW not, *Pyrophilus*, whether I ſhall need to add, that of theſe fetid remedies, which are volatile, and ſomewhat ſulphureous, as I choſe to mention to you but a few, to comply with my preſent haſte, which would not allow me to inſiſt on many: ſo in what I have delivered concerning theſe few, I have ſet down particulars the more fully and explicitely, becauſe I find the doctrine of volatile ſalts (though in my poor judgment worthy of a ſerious inquiry) perfunctorily, and indiſtinctly enough, handled by the chymical writers I have yet met with; which made me the willinger to contribute the few obſervations I could readily find, of thoſe I have had opportunity to make about them, towards the illuſtration of ſo important a ſubject, of which having elſewhere ſpoken in relation to phyſiology (as theſe fugitive bodies belong to the commonwealth of ſalt) I thought it might not be unacceptable to you, if I alſo conſidered them a while in relation to phyſick, and preſented you with ſome hints concerning their medical uſes.

## To the 136th Page,

[*Where the author promiſes a declaration, how he would have his praiſes of medicine underſtood.*]

AND now, *Pyrophilus*, having finiſhed what I thought fit to add (at preſent) in the paſt appendix; I ſhould likewiſe put an end to the preſent exerciſe of your patience; but that this being my firſt treatiſe written to you concerning medical matters, and not being likely to be the laſt, which you will meet with among the papers deſigned you, I think it requiſite, and not unſeaſonable to declare to you here once for all, with what eyes I deſire you ſhould look upon what I have written, and ſhall write, to you concerning matters of that nature. And firſt, I muſt advertiſe you, that I am not ſo much a mountebank, as to recommend to you the remedies I mention as certain cures in the caſes, wherein they are proper. For he muſt have been extraordinarily happy, or very much unacquainted with the practice of phyſick, that has not found, that even thoſe medicines, which are moſt celebrated by the beſt authors, both Galenical and chymical, do ſometimes prove ineffectual as well as often proſperous; and the remedy preſcribed by the ſame phyſician to twenty patients ſick of the ſame diſeaſe has more than once been obſerved, though it have ſucceeded in nineteen, to fail in the twentieth. And indeed the cauſes of diſeaſes, the conſtitution of patients, and the complications of diſtempers are ſo very various, intricate, and obſcure, that it is extremely difficult even for the moſt knowing and experienced phyſician, to make an accurate and conſtant experiment in the therapeutical part of phyſick; and conſequently ſuch experiments are much leſs to be expected from me, whoſe condition as well as diſabilities forbid me to make the practice of phyſick my buſineſs, and allow me only to adminiſter it occaſionally, either to my own particular acquaintance, or to ſuch poor people, as are not able to gratify phyſicians, or to ſuch as I meet with, where there are not any: and thereby I am reduced to learn the virtues of divers of the remedies I have prepared by very few or none of my own immediate trials, but the relation of phyſicians, who do me the favour to adminiſter them for me. And therefore, though I endeavour to put them into the hands of faithful as well as ingenious men; yet not being allowed to be my ſelf a conſtant eye-witneſs of the effects they produce, I muſt here for all theſe reaſons ſolemnly profeſs to you, that as I do not ſet down medicinal experiments with the ſame poſitiveneſs, that I do phyſiological ones, ſo I do not intend to venture the repute of being a faithful relater of experiments, upon the ſucceſs of any medicinal receipt or proceſs.

YET in the next place I muſt tell you, that you would perhaps do me but right, to think, not only that the chymical preparation of remedies are, if you underſtand them aright, candidly ſet down, though the virtues aſcribed to them do not conſtantly upon all trials diſplay themſelves; but that I have not raſhly and inconſiderately, or upon uncertain rumours, recorded the virtues of particular remedies, which may be good, though they be not infallible; it being ſufficient to make a medicine deſerve the title of good, that it be often (in ſome degree at leaſt) ſucceſsful, though now and then it prove not available; eſpecially if it be otherwiſe ſo ſafe and innocent, that even when it proves not proſperous, it weakens not nature, nor is otherwiſe noxious. And we muſt not, *Pyrophilus*, be ſo timid, as to ſuffer ourſelves to be perſuaded, that if a patient miſcarry after the uſe of the remedies, the fault muſt neceſſarily belong to the exhibited medicine. For oftentimes nature will in ſpite of remedies make a metaſtaſis of the peccant matter, and ſo impair the condition of the patient; and much oftner before death, the conflict of ſtruggling nature and the conquering diſeaſe doth manifeſt itſelf in horrid and dreadful ſymptoms, which ſome envious or ignorant doctors (for the more learned are wont to be more equitable, and leſs partial) injuriouſly impute to the chymical remedy, given before the appearing of thoſe ſymptoms; never conſidering, that the like accidents are wont to attend dangerous diſeaſes, and dying perſons, where Galenical remedies only, and no chymical ones at all, have been adminiſtered. And that divers of the moſt eminent, and methodical of our modern phyſicians ſcruple not to uſe frequently both *crocus metallorum*, *merc. dulcis*, and ſome other chymical remedies, and to impute the miſcarriages of the patients, that uſe them to their diſeaſes; though not many years ſince, all the frightful ſymptoms accompanying the dying perſons, to whom they had been exhibited, were confidently imputed to thoſe medicines. To which let me add, *Pyrophilus*, that oftentimes it may be very juſt to prize an empirical remedy more than a Galenical, though the methodiſt and the empirick have each of them, by his reſpective remedies, performed cures of divers patients in the ſame diſeaſe; partly becauſe empirical chymiſts are ſeldom reſorted to but in deſperate caſes, or till nature be almoſt ſpent, either by the violence of the diſeaſe, or the unproſperous operation of the medicines employed to remove it; and partly, becauſe the methodiſt helps his remedies, by premiſing the wonted evacuations (by vomit, ſiege, or by phlebotomy) by varying them according to emergent circumſtances, by ſkilfully and ſeaſonably adminiſtering them, and by ſtrict rules of diet; whereas the empirick oftentimes uſeth but a ſingle remedy, and uſually without premiſing general evacuations, exhibits it not to the greateſt advantage in relation to him, and other circumſtances, and is much more indulgent to his patient in point of diet:

Divers diſadvantages of chymical and empirical phyſick in the way of miniſtration.

ſo that when an empirick and a rational phyſician do, both in ſeveral patients, cure, for inſtance, the ſame pleuriſy, the diſeaſe may be very often judged to have been removed in one of the patients chiefly by the phyſician, and in the other by the remedy.

That chymical proceſſes ſtand more in need of clear relations, than Galenical.

In the third place, *Pyrophilus*, I muſt advertiſe you, that though I mention more chymical remedies than Galenical, yet it is not out of any partial fondneſs of the former, and much leſs from any undervaluation of the latter; but partly, becauſe chymical proceſſes being wont to be more unfaithfully, or obſcurely, ſet down by authors than Galenical receipts, I thought it might ſave you ſome labour, to receive from me a frequenter account of thoſe, than theſe; and partly, becauſe in many chymical preparations, divers conſiderable changes being to be wrought upon the concretes to be prepared by them, there is oftentimes ſo much of philoſophy to be learned by ſuch proceſſes, that the ſucceſs of them may prove inſtructive to you, though it ſhould acquaint you with their truth only, as they are chymical preparations, and not as they are medicinal receipts. But otherwiſe I love to look upon both chymical and Galenical remedies with an impartial eye, and think, that neither the former ought to be deſpiſed for the latter, nor the latter for the former: for as chymical remedies have commonly the advantages of being more durable, leſs clogging by their quantity, and leſs nauſeated by patients; ſo Galenical remedies have, when they are of equal efficacy, the advantages of being more cheap, (at leaſt quantity for quantity) more procurable, and ſooner prepared. And ſuch is the variety of caſes ariſing from the variety of conſtitutions and diſtempers, that in ſome of them the former ſort of remedies may be more proper, and in others, the latter may ſeem requiſite; and in ſome alſo, both ſorts may alternately be ſo uſeful, that neither of them can well be ſpared.

Errors in the time and doſe of chymical remedies.

In the fourth place, *Pyrophilus*, let me advertiſe you, that divers chymical remedies and ſome ſpecificks alſo, which are not chymical, have ſeemed upon trial leſs effectual than indeed they are, becauſe they have been tried by ſuch phyſicians as weaken their efficacy, by not adminiſtring them as they ſhould. For ſome phyſicians will never exhibit a chymical remedy, till the patient's ſtrength hath been almoſt tired, if not quite ſpent with the unproſperous uſe of divers others clogging and debilitating medicines. Others are ſo diffident of chymical remedies, that they never dare to exhibit them in a full doſe, nor by themſelves, but will blend a ſmall quantity of a chymical medicine, or a ſpecifick with other ingredients, which either conſtitute, with it, a medicine of new qualities, reſulting from that mixture, or at leaſt, much clog or enervate the activity and virtue of the chymical or ſpecifick ingredients: by which, even in ſo inconſiderable a doſe, theſe diſtruſtful doctors dare yet require, that great matters ſhould be performed. Of which injurious way of adminiſtring the remedies I recommend to you, *Pyrophilus*, I do not cauſeleſly deſire you to beware; as I may hereafter have occaſion to ſhew you, by particular inſtances, of the reaſonableneſs as well of this advertiſement, as of the others, which I either have given you, or ſhall give you, in this and other papers. And another ſort of phyſicians there is, who are of ſo deſpondent and rather partial an humour, that if a chymical remedy, or a ſpecifick, do not preſently perform the hoped-for cure, though they find, that, even upon their diſadvantageous manner of adminiſtring it, it doth good, yet they will quickly deſiſt from the uſe of it; and becauſe it doth not do wonders, they will not ſcruple to affirm, that they have tried it, and found it do nothing: whereas they are wont to continue their own courſes of phyſick without diſcouragement, though it be uſually ſome weeks before the patient find any good by them, and oftentimes (as numbers of the printed obſervations of phyſicians, as well as daily experience teſtify) the patient is, by the tedious courſe of phyſick he has gone through, very little bettered, if not much impaired. Which I ſpeak, *Pyrophilus*, not with an intention to diſparage phyſicians in general, the moſt learned and ingenious of them being free enough from the partiality I here take notice of; but to keep good remedies from being diſparaged by the envious or unſkilful trials of bad adminiſters. And though indeed ſome chymiſts are ſo vain-glorious or unwary, as to promiſe, that the operation of their remedies ſhould be as well ſudden, as effectual; yet if the medicines themſelves be found available, although not ſwiftly ſo, that ſlowneſs ought to make us but condemn the boaſtings of the man, not reject the uſe of the remedies.

AND in the laſt place, *Pyrophilus*, I muſt advertiſe you, not to expect, that every one of the remedies I commend ſhould be phyſick and phyſician too: I mean, that it ſhould of it ſelf ſuffice to perform the cures of thoſe diſeaſes, againſt which it is commended. For medicines are but inſtruments in the hand of the phyſician, and, though they be never ſo well edged and tempered, require a ſkilful hand to manage them: and therefore I cannot but admire and diſapprove their boldneſs, that venture upon the practice of phyſick, wherein it is ſo dangerous to commit errors, barely upon the confidence of having good receipts. For though, by converſation with eminent phyſicians, I have found the learnedeſt of them to diſagree ſo much about the nature and cauſes of diſeaſes, that I dare not deny but that he may proſperouſly practiſe phyſick, that either ignores or diſſents from the received doctrines of the ſchools concerning the cauſes of diſeaſes, and ſome other pathological particulars; yet I cannot but diſlike their boldneſs, who venture to give active phyſick, either in intricate or acute diſeaſes, without at leaſt a mediocrity of knowledge in anatomy, and ſo much knowledge of the hiſtory of diſeaſes, as may ſuffice to inform them in a competent meaſure, what are the uſual ſymptoms of ſuch a diſeaſe, what courſe nature is wont to take in dealing with the peccant matter, and what diſcernible alterations in the patient's body do commonly fore-run, and thereby fore-tell a criſis, or otherwiſe the good or bad event of the diſeaſe. To all which is to be added ſome tolerable meaſure of knowledge, not only of the *materia medica*, and the chief ways of compounding ſeveral ingredients into medicines of ſeveral forms and conſiſtencies, as circumſtances may require; but alſo of the orderly and ſeaſonable adminiſtration of the helps affordable by them. Theſe particulars, *Pyrophilus*, might eaſily be enlarged on; but having neither the leiſure nor deſign to handle them common-place like, I ſhall only give you this account of my requiring, in the profeſſed practiſer of phyſick, ſome knowledge both of the *materia medica*, and the method of compounding and adminiſtring remedies, that (excepting perhaps the *arcana majora*, as chymiſts call them) even the beſt medicines, by being unſeaſonably or proſperouſly adminiſtred, eſpecially in acute diſeaſes, where nature's motions are to be diligently watched, and ſeconded, may do a patient as much harm, as the orderly and ſkilful adminiſtration of them can do him good. And that he, that has nothing but one good receipt for a diſtemper, and knows not how to vary it by adding, omitting, or ſubſtituting other parts of the *materia medica*, as urgent occaſion ſhall require, may oftentimes find himſelf reduced either to ſuffer his patient to languiſh helpleſs, or to venture by curing him of one diſeaſe to caſt him into another. For ſometimes the patient's conſtitution makes the medicine preſcribed by the receipt unfit to be adminiſtred; and ſometimes too the diſeaſe, for which the receipt is proper, is in the patient complicated with ſome other diſtemper, which may be as much increaſed by the ſpecifick, as the other diſeaſe may be leſſened. I know, for inſtance, ſome eminent men, that are wont to cure very ſtubborn venereal diſtempers, by a chymical pre-

That a competent meaſure of knowledge is abſolutely neceſſary to a practiſer of phyſick.

paration (which ſome of themſelves have been pleaſed to diſcloſe to me) of the Indian plants, ſarſaparilla, guaiacum, *&c.* But if theſe men met with patients, ſuch as thoſe, which *Euſtachius Rudius* mentions himſelf to have often met with, who, upon the uſe of the leaſt quantity of guaiacum, though corrected with cold ingredients, were wont to be preſently affected with ſuch ſharpneſs of urine, and inflammation of the parts, to which urine relates, as hazarded their lives; they would be reduced, as well as our author confeſſeth himſelf to have been, to have recourſe to mercurial or other remedies. To which we may add, that the uſe of ſarſaparilla, and guaiacum is generally forbidden by the warier ſort of phyſicians, in thoſe patients, whoſe venereal diſtempers are complicated with heat or inflammation of the kidneys or liver. And ſometimes alſo it happens, that the very outward form of the medicine preſcribed by the receipt, is not fit, or perhaps poſſible to be adminiſtred: for, not to mention, that divers patients can retain no purgative phyſick exhibited in the form of a potion; and ſome others are as apt to vomit up, whatever is given them in the form of pills; not to inſiſt on this, I ſay, I ſhall content my ſelf, to relate to you a memorable caſe, that happened a while ſince to a phyſician of my acquaintance. He was called to a luſty young woman, who, upon an accidental but violent cold, was ſuddenly taken with ſuch a conſtriction of the parts inſervient to ſpeech and deglutition, as made her altogether unable either to ſpeak or ſwallow any thing at all: and having thus continued ſome days in ſpite of clyſters or other remedies, preſcribed by a very learned phyſician, and in ſpite of endeavours to excite vomiting, by making her hold emetick things in her mouth; the poor woman was in great danger (when my acquaintance came to her) of periſhing for hunger. What in this caſe could be expected from the beſt remedies, that muſt neceſſarily be taken in at the mouth? Wherefore the phyſician finding her yet ſtrong enough, and without fever, and yet her caſe almoſt deſperate, did as judiciouſly as luckily preſcribe a clyſter, wherein to ordinary ingredients were added (as himſelf a very few days after told me) about four ounces of the infuſion of *crocus metallorum*, with an advice, that it ſhould be kept in as long as poſſibly ſhe could; and by this medicine, nature being ſufficiently irritated, there quickly followed upon it ſome violent vomiting, and upon them a liberty both of ſwallowing and ſpeaking. [And ſince this, a young gentleman and fellow-traveller of mine had the organs of deglutition ſo ſtrangely weakened without any manifeſt cauſe, that though he were able to make me a viſit, and acquaint me with his caſe, yet he was very apprehenſive, he ſhould in a very few days be ſtarved; and being unable to ſwallow remedies, had quickly periſhed in deſpite of the *arcana majora* themſelves, had he been maſter but of ſuch of them as (like thoſe wont to be magnified by chymiſts) muſt be taken into the body; if a very happy phyſician, to whom I directed him, had not by a very efficacious and ſpecifick medicine, externally to be applied, ſeaſonably reſcued him from ſo unuſual and deſperate a caſe.] But, *Pyrophilus*, as I would not, upon the ſcore of good receipts, have the phyſician's ſkill deſpiſed, or thought uſeleſs; ſo I wiſh, that the phyſician's ſkill may not make him deſpiſe good receipts. For we have often ſeen (eſpecially in outward affections) not only empiricks and chirurgeons, but even ladies and old wives, with a lucky compoſition preſcribed by a receipt, perform more conſtant and eaſy cures of the particular diſtemper, for which that receipt is proper, than even learned phyſicians by their extemporary, though pompous and artificial preſcriptions. And the illuſtrious Lord *Verulam* (one of the moſt judicious naturaliſts, that our age can boaſt) thinks fit to take notice of it as a deficiency, that receipts by long experience approved are not more cloſely, and, as he ſpeaks, religiouſly adhered to, but altered upon every light occaſion. And in the ſame chapter, to anſwer the principal

De Augment. Scient. lib. 4. cap. 2.

**The Lord Verulam's** judgment, that approved receipts ought not to be altered, but religiouſly adhered to.

Crato's judgment had herein, and the author concurs with that eminent phyſician.

Conſil. 322.

as well as the moſt obvious objection in this matter, 'That, ſays he, any man 'induced by ſome ſpecious reaſon ſhould be of opinion, that it is the part of a 'learned phyſician (reſpecting the complexions of patients, their age, the ſeaſon of 'the year, cuſtom, and the like) rather to accommodate his medicines as occaſions 'ſuggeſt, than to inſiſt upon ſome certain preſcripts, is a deceivable aſſertion, and 'which attributes too little to experience, too much to judgment.' And a little above, he goes much farther than we pretend to do; for ſpeaking of the neglect of the uſe of particular receipts, which, as he ſpeaks, by a kind of propriety, reſpect the cure of particular diſeaſes, he adds, ſeverely enough, 'that the phyſicians have 'fruſtrated and taken away the fruit of traditions, and approved experience by their 'magiſtralities, in adding, and taking out, and changing ingredients of receipts at 'their pleaſure, and almoſt after the manner of apothecaries, putting *in quid pro quo*; 'commanding ſo preſumptuouſly over the medicine, as the medicine can no longer 'command the diſeaſe.' Thus far our judicious author: But I will rather chuſe to expreſs to you my ſenſe on this whole ſubject of receipts, in the words of that experienced phyſician to three emperors, *Johannes Crato: De morbi natura* (ſays he) *cauſa, locoque affecto, medicus diligenter cogitet, atque in eo plus quam in certis medicamentorum mirificis formis ſitum putet. Medicinam tamen expertam cum ratione adhibitam plus valere quàm ea, quæ interdum ſubitò à doctiſſimo etiam medico magna ratione exhibita excogitatur, non dubito: atque hac in parte rationales etiam medicos empiricis cedere debere de ſententia Hippocratis ſtatuo.* Only I muſt add by way of explanation, that this ſentence is to be underſtood to expreſs my ſenſe, when the medicines uſed are not very extraordinary, but ſuch, as *Crato* employed, and hath left us in his writings: for there may poſſibly be ſuch effectual ſpecificks, and ſuch powerful and commanding remedies, that the efficacy of the medicine may (at leaſt in ſome particular diſeaſes) excuſe and repair much want of ſkill in the preſcriber.

**Helmont.** in Arcan. Paracelſ. pag. 787. Of the greater arcana, and more univerſal medicines, the efficacy of which may compenſate for want of ſkill in the preſcriber. Helmont. in Arcan. Paracelſ. pag. 790.

IF the teſtimony of *Helmont* concerning the *Arcana* of *Paracelſus* be conſiderable, even in a tract (where either out of emulation or judgment, he endeavours ſomewhat to depreciate both them and their author) much greater things might be boldly affirmed of ſome *Arcana*; for *Fateor lubens* (ſays he, ſpeaking of *Paracelſus*) *me ex ejus ſcriptis profeciſſe multum, illumque potuiſſe, per remedia ad unitatis ſymbolum aſcendentia, ſanare lepram, aſthma, tabem, paralyſin, epilepſiam, calculum, hydropem, podagram, cancrum, atque ejuſmodi vulgo incurabiles morbos: attamen Paracelſum fuiſſe ignarum radicis vitæ longæ, tam ex ejus ſcriptis & medicaminibus quam ex obitu collegi, &c.* And in the ſame tract, juſt before he comes to enumerate *Paracelſus*'s *Arcana*, *Concedo*, ſaith he, *univerſales aliquot medicinas, quæ ſub uniſono naturæ longè gratiſſimo, inſenſibiliter poſt ſe vinctum educunt hoſtem, cum egregia organorum depuratione; concedo pariter appropriatas aliquot quo univerſalis amplitudinem in ſpecificis morborum directionibus æmulantur.* And among thoſe *Arcana* themſelves, that is ranked but in the ſecond place, of which he gives this character; *Sequitur dein mercurius vitæ, ſtibii proles integri, quæ omnem morbi nervum penitus abſorbet.*

AND becauſe another *Arcanum* doth not ſo powerfully renovate, as that laſt mentioned, and two more; he allows to thoſe three others the precedencies of that, whereof he yet ſaith, *Quarto loco eſt mercurius diaphoreticus, melle dulcior, & ad ignem fixus, ſolis horizontis omnes proprietates habet: perficit enim quicquid medicus & chirurgus poſſint optare ſanando.* But becauſe, that any medicine ſhould be qualified to deſerve ſuch ſuperlative encomiums, may ſeem a thing fitter to be wiſhed than credited, I would not diſſuade you, till the chymiſts cures have made good their maſters brags, to be altogether of our author's mind, who ſomewhere profeſſes, *Se morbum non diſtinguere, ſi remediis* (ſure he ſpeaks of ſuch remedies, as he thought he had) *ſit*

The ſum and concluſion of the point in controverſy.

*ſumma bonitas.* But yet you may perchance aſcribe much more even to remedies far inferiour to the *Arcana majora*, in the caſes, wherein they are moſt proper, than many are willing to believe. Inſomuch that I have ſometimes obſerved with wonder, that an excellent perſon (whom I need not name to you) cures the rickets generally in children of ſeveral ages and complexions, without having hitherto failed (as ſhe profeſſes) in any one, by preſcribing no other remedy, than the ſingle uſe of the above deſcribed colcotharine flowers, which I preſented her with. And a couple of phyſicians alſo, to whom I recommended them, tell me, they have tried them in the ſame diſeaſe with the like ſucceſs, as this lady hath hitherto met with. And I remember, that eminently learned and experienced phyſician Dr. *G. Boat*, (of whoſe ſkill both your excellent mother and you have had good proof) ſolemnly aſſured me, as I elſewhere alſo note, that he knew a phyſician, who conſtantly cured within two or three fits all agues, whether recent or radicated, in perſons of all ages, ſexes, and complexions indiſcriminately, with one ſingle outward application to the patient's wriſts; but that this envious doctor would never part with it to our friend, or any elſe, no not upon his death-bed: only Dr. *Boat* diſcovered, that ſpiders, or ſomething coming from them, were main ingredients of his *Pericardia*.

And indeed there are certain preparations and compoſitions of remedies ſo lucky, and whoſe ſucceſs doth ſo much exceed expectation, and the efficacy of common compoſitions; that the ſame phyſician, whoſe they are, may upon ſeveral occaſions preſcribe an hundred others, each of which he may think as rational as any of thoſe, which nevertheleſs ſhall be all of them much inferiour thereunto. And therefore I wonder not, that the moſt learned of the methodiſts themſelves have much valued and celebrated ſome peculiar proceſſes and receipts, as here amongſt us (to mention no others) the famous Sir *Theodore Mayerne* was wont almoſt in all obſtructions, cachexies, and hydropical diſtempers, to magnify and uſe that peculiar ſalt of ſteel of his, which he was pleaſed to call *Anima hepatis*.

And to theſe domeſtick inſtances (which I might eaſily accumulate) of the eſteem eminent phyſicians have made of receipts, I might add very many foreign ones. Nay, *Galen* himſelf, who has ſo copiouſly treated of the *Materia medica*, and the compoſition of medicaments, though he were ſufficiently expert at drawing up receipts, doth yet in his book *de compoſitione medicamentorum*, and elſewhere, tranſcribe, and ſometimes commend (and mention his having uſed) divers of the compoſitions of ancienter phyſicians, and eſpecially magnifies *Andromachus* his treacle.

I might, *Pyrophilus*, here mind you, that we ſee, that chymiſtry, as incompleat as yet it is, has been able ſo much to improve the preparation of remedies, as to afford us ſome, which are ſo innocent as well as efficacious, that in the diſeaſes they principally reſpect, they require not, as of neceſſity, near ſo much of theorical ſkill, as others do in the adminiſter. I might likewiſe take notice, that experience alſo teacheth, eſpecially by what we ſee performed by the *Spaw*, and ſome other mineral waters, that one medicine may be ſo richly endowed, as to be more effectual againſt ſeveral differing diſeaſes, than even the better ſort of other remedies againſt any one particular diſeaſe.

I might further repreſent as ſomething that makes yet more to my preſent purpoſe, that though every body can adviſe his ſick friends to an air, that is famouſly healthful, if there be any within a convenient diſtance from them; yet there are ſome airs ſo eminently good, and that not upon the account of any one predominant quality, that makes them oppoſite to a diſeaſe ſpringing from its contrary, but from a hidden temperature, or certain friendly effluvia, that they alone often cure variety of diſeaſes in perſons of differing ages and complexions: as navigators obſerve in the Iſle of *St. Helen*, where the Spaniards and ſome other Europeans, in their paſſage to the *Indies*, often leave without phyſicians great numbers of ſick, whom they find for the moſt part recovered at their return. And that ſometimes even the acuteſt diſeaſes may by the ſanative ſteams, that enrich the air, be cured almoſt in a trice, is aſſured by thoſe, that have lived in *Grand Cairo*, who have affirmed to me, what the learned *Proſper Alpinus*, who ſo long practiſed phyſick there, aſſures us, that upon *Nilus*'s beginning to overflow, though in the heat of ſummer, there enſueth a ſudden recovery of thoſe multitudes of perſons of differing ages, temperatures, ſexes, *&c.* which there happen at that time to lie ſick of the plague. Theſe things I ſay, *Pyrophilus*, and more I might add, to what you find diſperſed here and there in the eſſays, which this paper accompanies, towards the inferring, that we ſhould not haſtily conclude it impoſſible, that there may be found ſuch medicines, as may be more than particular and ſpecifick remedies, without requiring the giver to be a great phyſician. But to draw at length to a concluſion, I ſhall rather ſum up my preſent thoughts of this matter, thus.

Ordinary receipts without an ordinary meaſure of ſkill in phyſick are not raſhly to be relied on, eſpecially in acute diſeaſes; where, by giving medicines, otherwiſe innocent enough, to loſe the opportunities of adminiſtring proper ones, may be very prejudicial; and where ſometimes the ſeveral ſeaſons of the diſeaſes do require ſuch differing remedies, if they be but ordinary ones, that a medicine proper enough for the diſeaſe at one ſeaſon of it, may do miſchief at another. But if indeed there be noble and extraordinary *Arcana*, that work rather by ſtrengthning and reſtoring nature, and reſolving, or otherwiſe deſtroying the peccant matter they find any where in the body, than by irritating and weakening nature, or putting her as it were to a troubleſome plunge; the uſe of ſuch remedies may deſerve to be a little otherwiſe conſidered, as that, which may not ordinarily (for I ſay not ever) require more inſtruction than may be afforded to perſons not indiſcreet, by ſuch directions and cautions as may be divulged, or otherwiſe communicated, together with the remedies themſelves: as we ſometimes ſee, that by the help of ſuch inſtructions unlearned perſons, and even old wives, do with ſome one ſovereign plaſter, balſam or other outward remedy, cure many and various tumours, ulcers, and other ſores, in perſons of differing ſexes, ages, and complexions. And becauſe you will eaſily grant, that this example does far leſs accommodate our preſent purpoſe than does the caſe it ſelf, as I juſt now put it; I hope you will allow me to repreſent further, that at leaſt it ſeems not ſo rational to judge of all the remedies, that art improving nature can afford us, by thoſe, that are hitherto in uſe, either among methodiſts or vulgar chymiſts; but rather to think, that the nobleneſs of remedies will be advanced according as the art of preparing them ſhall be promoted; and that it is not ſo ſafe and eaſy, poſitively to determine the efficacy of the former, otherwiſe than in proportion to the diſcoveries we have attained to in the latter.

# SOME CONSIDERATIONS TOUCHING THE STYLE of the HOLY SCRIPTURES.

EXTRACTED

From ſeveral Parts of a **DISCOURSE**,

Concerning divers Particulars belonging to the **BIBLE**;

Written divers Years ſince to a **FRIEND**.

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## TO THE EARL of *ORRERY*,

One of the **LORDS JUSTICES** of the KINGDOM of *IRELAND*,

**LORD PRESIDENT** of the PROVINCE of *MUNSTER*, &c.

MY DEAREST BROTHER,

THAT ſacred book, which furniſhes our preachers both with their texts and a great part of their diſcourſes on them, being the ſubject, about which I am to entertain you, I preſume it will not much ſurprize you, if what I ſhall ſay, in repreſenting to you ſome conſiderations on that book, reliſh more of a ſermon than of a letter of compliment. And indeed it would ſo little become a perſon, that writes of my ſubject, and with my deſign, to ſtartle at the very beginning ſuch readers, as he deſires to find or make devout, with any thing written in the wonted ſtrain of epiſtles dedicatory; and the nature of the treatiſe, to which this paper is premiſed, does allow ſo little of that, whereof cuſtom, on ſuch occaſions, is wont to challenge ſo much; that I ſhould let this book come forth undedicated, were it not that the motives, that induced me to addreſs it to you, are of ſuch a nature, that I hope, that merely by a plain repreſentation of them I may comply with what makes me look upon this dedication as a duty, without departing from the ſerious deſign I propoſed to my ſelf in the dedicated book. Although then ſuch readers, as having peruſed your writings, ſhall caſt their eyes on mine, will, I fear, think it a bold preſumption in me to addreſs diſcourſes, concerning a ſtyle, to a perſon ſo much and ſo juſtly applauded for his; yet as ſeveral reaſons engage me to preſent you theſe thoughts, ſo the fear of paſſing for preſumptuous for ſo doing obliges me to mention ſome of thoſe reaſons. Whereof the firſt ſhall be, that your kindneſs for, and your reſemblance in many particulars to, *Theophilus*, makes me often fancy, that I am yet entertaining that rare perſon, when I write on the behalf of the ſcripture unto you. Who may alſo, I preſume, remember (which is my ſecond reaſon) that when, ſeven or eight years ago, I ventured to ſhew you divers of theſe papers, with others (that I yet ſuppreſs) belonging to the ſame treatiſe, you were pleaſed to give me ſuch a permiſſion, that in caſe they ſhould ever be made publick, I might addreſs what I had written at your friend's deſire particularly to you, as I took for an engagement, if not a command. So that how unlike ſoever the following treatiſe is to that beſt of books it would recommend; yet ſince you have thus made the preſent addreſs a duty, I muſt elect rather to betray to you my weakneſſes, than not manifeſt my obedience. And to theſe I muſt ſubjoin this third conſideration, (more prevalent perhaps with me than both the former) that (as a homely digger may ſhew a man a rich mine) whatever the book may be that I preſent you, that which I recommend to you is a matchleſs one; and will, if ſo diſcerning a reader ſhall bring as much aſſiduity as capacity to diſcover its prerogatives, appear ſo worthy of what I have ſaid of it, that I allow my ſelf a hope, the following conſiderations will prove ſo happy, as either to endear the ſcripture to you, or (by not appearing ſuch as ſo good a ſubject would ſuggeſt to a good pen) invite you to ſubſtitute better in their rooms. And in either of theſe caſes I ſhall not have cauſe to repent of having written them; ſince they will prove ſerviceable either to the book or to the man, to whom I moſt deſire to be ſo. And this hope I muſt again own to be the chief inducement of my venturing to preſent a fragment of an unpoliſhed treatiſe to a perſon, that is wont to write ſuch as are ſo eloquent and accompliſhed in their kind. For though ſevere, and not incompetent, judges of compoſures of this nature have been pleaſed to give theſe papers no diſapproving character; yet ſince I preſent them to you, the chief thing I dare pretend to in them is only (as the ſinging rare ſongs ill is wont, by an unheeded indignation, to engage the poſſeſſors of rare voices to make them admired) by diſcloſing my zeal and inſufficiencies, to invite you to reſcue ſo excellent a theme as the ſcripture from ſo dull a pen as mine, by employing your happy one in its defence and celebration: or, (if your partiality ſhould make you place any value on ſo unfiniſhed a piece) to convince you how capable of rare thoughts my ſubject is, by its being able to furniſh ſo barren a brain as mine with acceptable ones. And certainly, your pen having no leſs ſerved your fame than either your ſword, or your employments (how high ſoever;) it could not but bring the ſcripture more than a few of the moſt witty and illuſtrious votaries, if that eloquence were employed to enamour them of that divine book, that hath made them ſo generally in love with your celebrated *Partheniſſa.* I will not repreſent to you ſo pious an exerciſe of your rhetorick and muſe as a duty, for fear of leſſening the diſintereſtedneſs of the employment I recommend to you, by implying, that you cannot decline it without a fault. I ſhall rather invite your pen to prefer itſelf to, and grace religious ſubjects, by aſſuring you, that as there are none more worthy of your pen, ſo there are few pens more likely to ſucceed upon ſome of them than yours. Thoſe handſome eſſays your muſe hath charmed me with upon ſome parts of the bible have given me longings equally great and juſt, to ſee her, by a devotedneſs to ſuch heavenly themes, as happy in the choice of her ſubjects, as ſhe is wont to be in the embelliſhing of them; and to have her make that her chief employment, wherein it is beſt to do, what ſhe doth always, ſucceed well. And as with burning-glaſſes though we cannot make the ſun ſhine, yet when he doth vouchſafe us his heavenly beams, we can, with thoſe glaſſes, both increaſe light and heat, and carry and ſettle them here and there as we ſee cauſe: ſo though with wit and parts, their poſſeſſors could never have been able to engage God to ſend forth his light and his truth; yet now that revelation hath diſcloſed them, and now he hath been pleaſed to make them radiate in his heavenly word, men may, with knowledge and eloquence, happily recollect thoſe ſcattered divine beams, and uniting them in particular ſubjects, and kindling with them the topicks proper to warm and work on our affections, may powerfully illuſtrate truths, and enflame zeal. Towards the latter end of the enſuing papers you will find ſomething ſaid to perſuade our *Theophilus*, that the choiceſt poetical and rhetorical ornaments may, without injury to their luſtre, be employed about ſuch ſubjects as may be choſen in the ſcripture: but more and better things, to the ſame purpoſe, have ſince been ſaid by our ingenious friend Mr. *Cowley*, who not only has employed much eloquence to perſuade that truth in his preface to his poems, but has in one of them given a noble example, and conſequently a proof of it. I need not tell you, I mean his *Davideis*, a work and way of writing, which, ſince your muſe has already thought fit to celebrate, I hope ſhe will hereafter think fit to imitate. And this I wiſh the more earneſtly, becauſe it hath been obſerved, that ſecular perſons of quality (of whom I have elſewhere occaſion to name divers) are generally much ſucceſsfuller in writing of religion, (to gentlemen eſpecially) than ſcholaſticks or men in orders; not only becauſe their ſtyle and way of writing is obſerved to have in it ſome pleaſing *Je ne ſçay quoy*, ſomething of eaſy, genuine and handſome, that's peculiar to it, (differing from regular eloquence, as a good mien doth from beauty) and reliſhes of the native gracefulneſs wont to attend on what they do or ſay; but becauſe their writings attract more readers by the authors conſpicuouſneſs, and make deeper impreſſions in them, by being ſuppoſed more diſintereſted, and looked upon, not as ſuggeſted by their profeſſion or ſelf-ends, but as the ſincere dictates of their unbridled ſouls. For my part, though I am not ſo happy as to be much concerned in all the precedent conſiderations, yet thoſe, that you will find, towards the end of the longeſt digreſſion in the following diſcourſe, have been ſo prevalent with me, that though ſome very fair and very perſuaſive perſons (whom perhaps I need not name to you) did, when I was writing the annexed treatiſe, labour to divert my pen to ſome more youthful and more faſhionable compoſures, by flattering me with a perſuaſion, that in thoſe attempts of that nature I had formerly occaſion to make, I was not altogether unlucky; yet I, that would bring my ſelf to prefer to a whole wood of bayes the leaſt ſprig of the tree of life, am inclined to think, that a Chriſtian may poſſibly find a higher ſatisfaction in perſuading men to pay praiſes to the ſcripture, than in receiving them from all the world beſides; and would think it more deſirable, (were the choice his) to diſcountenance prophane wit, than live unrivalled in the glory of it. And though, for my own particular, ſuch a temper be, I fear, more my aim than my attainment; yet when I write of ſacred ſubjects, I had rather a book of mine ſhould reſemble the moon, which, though ſhe be but ſmall, leſs elevated, and full of imperfections, lends yet a uſeful light to men, and produces here and there a motion that obeys a heavenly influence, than a ſtar of the firſt magnitude, which though more high, more vaſt, and more flawleſs, ſhines only bright enough to make it ſelf conſpicuous. Pardon me therefore, my deareſt brother, if my concern for religion and you have made me importunate in appearing ſo eagerly ſolicitous to ſee your applauded pen ſanctified by, and adorn the beſt of ſubjects: to engage you to which, if the enſuing diſcourſe may but be ſo fortunate as in any degree, or upon any ſcore, to contribute any thing, I ſhall either not eſteem it a trifle, or not regret the having written it. For it is not always ſo deſpicable a piece of ſervice as may be imagined, to endear, by particular conſiderations, an excellent book, (and how much more that incomparable book the ſcripture?) to a perſon capable of diſcovering and making uſe of the rare things it contains. To which purpoſe I might offer you divers more ſerious inſtances, but ſhall only at preſent (a little to divert you) take this occaſion to tell you, that *Ben. Johnſon*, paſſionately complaining to a learned acquaintance of mine, that a man of the long robe, whom his wit had raiſed to great dignities and power, had refuſed to grant him ſome very valuable thing he had begged of him, concluded with ſaying, with an upbraiding tone and geſture to my friend; *Why, the ungrateful wretch knows very well, that before he came to preferment, I was the man, that made him reliſh* Horace.

BUT to return to the following book, though I hope you do not think me ſo vain as to doubt, that it is ſuffered to come abroad with imperfection enough to need my excuſes and your pardon; yet ſince the treatiſe it ſelf is ſo unmeaſurably prolix (for a part of an eſſay) it were unfit the addreſs of it ſhould be ſo too; and give your patience as great an exerciſe upon the ſcore of its quantity, as upon that of its quality. And therefore, referring you for what I might ſay of apologetical to what I ſay to the reader, I ſhall only add, that though, in Epiſtles Dedicatory, cuſtom hath made it a kind of rudeneſs not to expatiate in praiſes, and conclude with complements; and though what you have acted, and what you have written, might ſupply a perſon leſs concerned than I with matter for a panegyrical addreſs; yet ſince I told you, at the beginning of this letter, I ſhould rather preach than compliment in it, and ſince praiſes fit to be aſcribed to my Lord *Orrery* would be unfit to be aſcribed him by his brother; and ſince alſo it were ſcarce more uneaſy for me to make you any other than ſeeming complements, than it were preſumptuous to addreſs any at all to ſo great a maſter in the art; I ſhall both decline praiſes, which not to ſeem flatteries, where you are not known, would perhaps be thought detractions where you are; and venture to conclude this letter, as I have begun and continued it, without compliment, upon the ſcore of being without, if not above any.

My deareſt Brother,

Your moſt Affectionate Brother,

and moſt Faithful Humble Servant,

*ROBERT BOYLE.*

# *To the* READER.

*The author having with the following diſcourſe ſent to the publiſher a letter, which contains almoſt all the particulars that would be requiſite to be taken notice of in a preface, it is thought fit to premiſe, inſtead of it, the letter itſelf, as it was addreſſed to Mr.* P. P. A. G. F. I. *(to favour whoſe modeſty, he is not now more openly named).*

SIR,

YOU will perhaps think it ſtrange, that a perſon obſequious enough to thoſe he loves ſhould be able to hold out ſo long againſt the importunity of two ſuch powerful ſollicitors, as my willingneſs to own a veneration for the ſcripture, and my unwillingneſs to deny you any thing. But if you will give me leave to acquaint you with the conſiderations, that have hitherto diſſuaded me from the publication of the papers you preſs for, you will, I preſume, rather marvel at my reſolving at laſt to comply with your deſires, than that I have been ſomewhat long conteſting, before I could take up ſo oppoſed a reſolution. Firſt then, the treatiſe, of which the papers you deſire make a part, was written nine or ten years ago, when my green youth made me very unripe for a taſk of that nature; whoſe difficulty requires, as well as its worth deſerves, that it ſhould be handled by a perſon, in whom nature, education, and time have happily matched a ſenile maturity of judgment with a youthful vigour of fancy. Next, the diſcourſe I have mentioned being written to a private friend, who put me upon that taſk, I not only had a theme of another's chooſing impoſed upon me, for which he was pleaſed to think me much more fit than I had reaſon to think myſelf, but was by the freedom allowable among friends tempted to vent and expreſs my thoughts with more negligence, than were proper to be made uſe of in a ſolemn diſcourſe intended for publick view. The contrary of which were yet very requiſite for a perſon, who though he have, by I know not what unhappy fate, been caſt upon the learning divers languages, has yet too great a concern for the knowledge of things to be a diligent or ſollicitous conſiderer of words; and ſo was more fit to write almoſt of any thing, than of a ſtyle, or of matters rhetorical. Beſides, that my Eſſay touching the Scripture having not been all written in one country, but partly in *England*, partly in another kingdom, and partly too on ſhipboard, it were ſtrange, if in what I writ, there did not appear much of unevenneſs, and if it did not betray the unleiſuredneſs, and reliſh of the unſettledneſs of the wandering author, who, by thus rambling, was reduced, for want of a library, to comply with the requeſt of his friend, who was more deſirous to receive from the author apples and pears growing in his own orchard, than oranges and lemons fetched from foreign parts: whereby I was condemned not to enrich my diſcourſe with what I might have borrowed, of real and valuable, from the eloquent compoſures of more happy pens. But theſe, Sir, are not all the determents, that oppoſed my obeying you; for beſides theſe diſadvantages, with which the diſcourſe itſelf was written, that part of it you demand muſt appear with peculiar as well as great diſadvantage: for in an intire and continued diſcourſe, the ſeveral parts, that compoſe it, do mutually afford light and confirmation to each other. And therefore, though whatſoever I here preſent you, touching the ſtyle of the ſcripture, had been written altogether in ſome one place of the diſcourſe, whereof it makes a part; yet I could not diſmember it from the reſt, without a great deal of injury, as well to it as to the reſt of the treatiſe.

But this is not the worſt of my caſe; for though I did, in one part of my eſſay of the ſcripture, more profeſſedly apply myſelf to the conſideration of its ſtyle; yet, becauſe divers things were interwoven even in the diſtinct part, which were not ſo fit for publick view; and becauſe that in divers of the other parts of my eſſay I had here and there, frequently enough, occaſion to ſay ſomething of the ſame theme, I have been obliged, that I might obey you, not only to diſmember, but to mangle the treatiſe you peruſed, cutting out with a pair of ſciſſars here a whole ſide, there half, and in another place perhaps, a quarter of one; as I found, in the other parts of my diſcourſe, longer or ſhorter paſſages, that appeared to relate to the ſtyle of the ſcripture, that I might give you at once all thoſe parts of my eſſay, which ſeemed to concern that ſubject. And though I have, here and there, by dictating to an amanuenſis, inſerted ſome lines or words, to make the looſe papers leſs incoherent, where I thought it eaſy to be done; yet in many others I have only prefixed a ſhort black line to the incoherent paſſages, if I found they could not be connected with thoſe, whereunto I have joined them, without ſuch circumlocution, as either the narrowneſs of the paper would not permit, or my preſent diſtractions (which you know are not a few) and the weakneſs of my eyes, would not allow of. For to compleat my unfitneſs to obey you with any thing of accurateneſs, I muſt, to obey you at all, do it, both when I have other compoſures in the preſs, and when the diſtemper in my eyes makes me ſo far from daring to tranſcribe the papers I ſend you, that I might alter them, according to the exigency of your deſign in them, that I durſt not ſo much as read them over, but with another's eyes. To which I muſt add, that, beſides all theſe diſadvantages I have already mentioned, I cannot but foretel, that the following diſcourſe may prove obnoxious to the cenſures of differing ſort of readers, and particularly to thoſe of courtiers, for too neglected, and thoſe of critics, for too ſpruce a dreſs. By all which, I preſume, you will be eaſily induced to believe, with me, that I cannot expoſe the papers you deſire ſo much to their diſadvantage, and my own, without ſome exerciſe of ſelf-denial; ſince, without needing much foreſight, I may well apprehend, that I ſhall hereby hazard the loſs of the moſt part of whatever little reputation, in this nature, any of my former moral or devout compoſures may, among favourable readers, have procured me.

But, by this time, Sir, I ſuppoſe not only, that you have left wondering at my making ſome difficulty to put the annexed papers into your hands, but that I owe you, and my other friends, an account, why I now conſent to a compliance with deſires, which ſuch powerful conſiderations would diſſuade my aſſenting to.

My firſt inducement then to what I do, is the favourable character, that you and ſome other very competent judges have been pleaſed to give me of theſe papers; and eſpecially your thereupon preſſing their publication upon me as a duty, whereto I ſtand obliged, to thoſe many readers, whom you would have me think likely to be benefited thereby. For in ſuch caſes, where knowing and ſober perſons think there is a great probability of a diſcourſe's doing good, it is not impoſſible, but that an unwillingneſs to have it publiſhed may not proceed out of modeſty, as from ſome ſecret pride, almoſt as unjuſtifiable, as if a phyſician ſhould refuſe to come abroad upon an urgent occaſion, becauſe he has not his beſt clothes on, or is not carefully dreſſed. And therefore, when I incline to make, with you, a caſe of conſcience of the matter, I think myſelf obliged, whatever my private apprehenſions may be of the ſucceſs, to do my duty, and leave events to the wiſe and ſovereign diſpoſer of them. It is not, that I have the vanity to expect, that I ſhould convert obſtinate and reſolved cavillers, nor much inſtruct the great clerks; but ſince I have not yet met with ſuch a diſcourſe, as I intended mine to be; and ſince the greater part of the things I have written in it will not, perhaps, be elſewhere met with; I hope, that what I have ſaid may not be uſeleſs to thoſe, who have conſidered the ſubject, I treat of, leſs attentively than I have done, and may, if not procure a veneration for the ſcripture in thoſe that are altogether indiſpoſed to it, yet at leaſt increaſe or confirm it in thoſe, that have already entertained it; and furniſh ſuch devout perſons with ſomething to alledge on the ſcripture's behalf, who are better furniſhed with affections than with arguments for it. And I the leſs ſcruple to allow myſelf ſuch a hope, becauſe you have been pleaſed to make, not only to me, but to others, ſuch a mention of the following papers, that after your preference of them to the other pieces of devotion, you have yet ſeen of mine (without excepting that diſcourſe of *Seraphick Love*, which yet has had the luck to be ſo favourably entertained by readers of all ſorts) I ſhall confeſs to you, that as ſome of them do now appear very much diſlocated and mangled, ſo others were penned with more care, than any other of my writings about matters theological. And indeed I conceived my ſelf obliged, in point of gratitude as well as duty, to ſpeak as advantageouſly as I could of the ſcripture; becauſe, if I may without vanity make ſuch an acknowledgement, I am ſenſible I have been benefited by it, and might have been much more ſo, if I had been as diſpoſed to learn, as the matchleſs book is qualified to teach. And I confeſs to you alſo, that ſince the phyſiological writings I have been induced to publiſh of late, and the ſort of ſtudies, to which (for reaſons to be told you at a fitter opportunity) I ſeem, at preſent, to be wholly addicted to, make many look upon me as a naturaliſt; and ſince ſome perſons, as well philoſophers as phyſicians, have either faultily, or at leaſt indiſcreetly, given many men occaſion to think, that thoſe, that being ſpeculatively ſtudious of nature's myſteries, depart, as I often do, from the vulgar peripatetick philoſophy, and eſpecially if they ſeem to favour that, which explicates the phænomena of nature by atoms, are inclined to atheiſm, or at leaſt to an unconcernedneſs for any particular religion: Since, I ſay, theſe things are ſo, I was not unwilling to lay hold of this opportunity, to give a publick teſtimony, whereby ſuch as do not know me may be ſatisfied, (for I preſume, all that do know me, are ſo,) that, if I be a naturaliſt, it is poſſible to be ſo without being an atheiſt, or of kin to it; and that the ſtudy of the works of nature has not made me either diſbelieve the author of them, or deny his providence, or ſo much as diſeſteem his word, which deſerves our reſpect upon ſeveral accounts, and eſpecially that of its being the grand inſtrument of conveying to us the truths and myſteries of the Chriſtian religion; my embracing of which I know not why I ſhould be aſhamed to own, ſince I think I can, to a competent and unprepoſſeſſed judge, give a rational account of my ſo doing.

To all this, I might ſubjoin ſome apologies, which might perhaps ſerve to prevent, or withdraw, the cenſures of ſome ſorts of readers.

For to critics and philologers I could repreſent, partly, that I have not a little impoveriſhed my diſcourſe, by making uſe of books, to ſhun the repetition of what I found obvious already; partly, that when I wrote the eſſay, of which the enſuing treatiſe is a piece, I had thoughts of annexing it to annotations, wherein I hoped to illuſtrate, and by particular inſtances to exemplify, divers of thoſe things, which ſhould appear to require it, or which elſe the readers might ſuſpect I have ſlightly conſidered, becauſe I ſeem to make but a tranſient mention of them; and partly, too, that I ignored not the ſtricter interpretations given by modern critics to divers texts by me alledged; but that (not having opportunity to criticize) I was content to uſe them in their received, or obvious ſenſe; and have ſometimes employed them but by way of alluſion, or as arguments *ad hominem* (wherein ſome of my readers are like to acquieſce, though I do not) and ſometimes rather uſed them to expreſs, than prove my thoughts. And, indeed, in theſe popular diſcourſes, which are not written for, nor to be examined as regular diſputations, men uſe not ſo much to look whether every thing be a ſtrict truth, as whether it be proper to perſuade, or impreſs the truths they would inculcate; and eſpecially in compoſures of the nature of this of mine, men have been rarely cenſured for being ſometimes even indulgent to the exigencies of their themes. Thoſe, that require more of method than they will here find, may be advertiſed, that much of this ſcribble being deſigned to ſerve particular acquaintances of mine, it was fit it ſhould inſiſt on thoſe points they were concerned in; and that (conſequently) much of the ſeeming deſultorineſs of my method, and frequency of my rambling excurſions, have been but intentional and charitable digreſſions out of my way, to bring ſome wandering friends into theirs, and may cloſely enough purſue my intentions, even when they ſeem moſt to deviate from my theme. And as for the longer excurſions, which either you, or other judicious friends, would needs have me leave here and there, I have, for the eaſe of my peruſers, annexed to them ſome marks, whereby they may be taken notice of, to be digreſſions; that as I ſubmit to their judgment, who think they may be uſeful to ſome readers, ſo I may comply with my own unwillingneſs to let them be troubleſome to others; who by this means have an opportunity to paſs by, if they pleaſe, ſuch, as they ſhall not expect to find themſelves, (either upon their own ſcore, or that of their acquaintances) concerned in. To thoſe of the wits, who happening to be diſregarders of the ſcripture, may find themſelves upon that account uſed here with any ſhew of ſlighting or aſperity, I may add to what I have already ſaid in the papers themſelves, that it hath been, but as we pinch, and caſt cold water on the faces of perſons in a ſwoon, to bring them out of it to themſelves again; I having done it with as harmleſs intentions, as thoſe of the angel (mentioned in the *Acts*) when he ſtruck *Peter* on the ſide, not to hurt him, but to awake him, lead him the way out of the priſon he was bound in, and reſcue from imminent death. And if that will not ſatisfy ſome of the leaſt judicious, or the moſt deſperate, (for others I expect to find better affected or more moderate) I am willing to leave the intelligent and pious to judge between us; aſſuring thoſe, that are ſo much more jealous of their own honour than of God's, that as I writ to reclaim them, not to deprive them of the repute of wits, or ſhare it with them, ſo I ſhall not overmuch deplore the being by them denied a title, to which I have as little pretenſion as right. And (to diſpatch) I might add, that orators may not unjuſtly bear with ſome rudeneſſes in the ſtyle of a perſon, that profeſſes not rhetorick, and writes of a ſubject, that needs few of her ornaments, and rejects many as indecencies miſbecoming its majeſty: and that ſeverer divines may ſafely pardon ſome ſmoothneſs in a diſcourſe, written chiefly for gentlemen, who would ſcarce be fond of truth in every dreſs, by a gentleman, who feared it might miſbecome a perſon of his youth and quality ſtudiouſly to decline a faſhionable ſtyle. And if any divine would cenſure me for intruding upon his profeſſion, and handling my ſubject leſs ſkilfully than he would have done; I will not urge, that to write well on this ſubject is a taſk, which he that ſhall try, will perhaps find far leſs eaſy than one would imagine; but I ſhall rather tell him, that I hope I may obtain his pardon, by aſſuring him, that I ſhall be as little angry to be rectified in my miſtakes, as to be ſhown the way, when I am out of it, and as little troubled to have this diſcourſe, that but ſkirmiſhes with lazineſs and prophaneneſs, ſurpaſſed by another on the ſame ſubject, as to ſee another embracer of the ſame quarrel come in with a freſh regiment, to aſſiſt me againſt a formidable enemy, in a conflict I were engaged in but with a troop, or bring cannon againſt a fortreſs I had but ſakers to batter with. Yes, I ſhall be glad, if my dim ſhort-lived match but ſerve to light

Acts xii. 7, &c.

another's brighter torch; and ſhall think it a happineſs to have contributed, though but thus occaſionally, towards the elucidation, or ſplendour of the ſcripture. And conſonantly to this temper, I would beſeech any reader, that may ſo much want learning as to need ſuch a requeſt, not to meaſure what can be ſaid in the defence and celebration of the ſcripture's ſtyle, by what hath in the following diſcourſe been traced by the callow pen of a travelling layman. For I profeſs ingenuouſly, that there can as little be an unwelcomer as an unjuſter compliment placed upon me, than to miſtake any thing that I am able to ſay, and much leſs what I have ſaid, for the beſt that can be ſaid upon ſuch a ſubject. Nor is it my leaſt encouragement to conſent to the publication of ſuch incompleat writings, that the conſiderations already intimated will probably keep my readers from doing the ſcripture and their own judgment ſo great an injury.

But I ſee I have ſo far trangreſſed the bounds of a letter, that if I add any thing more of apology, it muſt be for having been ſo prolix already. Wherefore there ſcarce remains any thing for me, but to mind you, that ſince your perſuaſions have much contributed to my expoſing the following tract, incompleat as it is, your own credit is ſomewhat concerned in it as well as mine. And therefore I hope you will have a care, that there be no faults of the printer added to thoſe of the author, which do ſo little need additional blemiſhes; and eſpecially that there paſs no miſtakes of the punctuation. For in ſuch compoſures as this, if the ſtops be omitted, or miſplaced, it does not only leſſen the gracefulneſs of what is ſaid, but oftentimes quite ſpoil the ſenſe. And if by this care of yours (which your affection, both for the ſubject, and the writer makes me confident of) and by the authority of your approbation, I find theſe imperfect conſiderations to be ſo favourably received as to deſerve another edition; it will perhaps invite me to put them forth enlarged, and recruited with what I may meet with pertinent to this ſubject in ſuch other papers of mine concerning the ſcripture, as I had not yet the conveniency to get into mine own hands and look over. However, though I pretend not here to anſwer all objections againſt the ſtyle of the ſcripture; yet as I hope, I have been ſo happy as to anſwer ſome of them, and weaken moſt of the reſt; ſo if others, that are more able, will but employ themſelves as earneſtly in ſo uſeful a work, there is great hope, that ſome anſwering this objection, another that, and a third another, they may at length be all of them ſatisfactorily replied to. And in the mean time I ſhall think my labour richly recompenſed, if they either procure or eſtabliſh a veneration for the ſcripture in any of my readers; or do at leaſt encourage thoſe, that are qualified for a far more proſperous making ſuch an attempt, to undertake it, by ſhowing thoſe of them that know me, what were eaſy for them to do, whilſt they ſee what has been done even by me; whom ſure they will not think to be half ſo much an orator, as I hope ſo uneaſy a proof of his obedience will make you think him,

Sir, Your Affectionate Friend

and humble Servant,

*ROBERT BOYLE.*

### SOME

# CONSIDERATIONS

### TOUCHING THE

# STYLE of the HOLY SCRIPTURES.

THESE things, dear *Theophilus*, being thus diſpatched, I ſuppoſe we may now ſeaſonably proceed to conſider the ſtyle of the ſcripture: a ſubject, that will as well require as deſerve ſome time and much attention; in regard that divers witty men, who freely acknowledge the authority of the ſcripture, take exceptions at its ſtyle, and by thoſe and their own reputation divert many from ſtudying, or ſo much as peruſing, thoſe ſacred writings; thereby at once giving men injurious and irreverent thoughts of it, and diverting them from allowing the ſcripture the beſt way of juſtifying it ſelf, and diſabuſing them. Than which ſcarce any thing can be more prejudicial to a book, that needs but to be ſufficiently underſtood to be highly venerated; the writings theſe men criminate, and would keep others from reading, being like that honey, which *Saul*'s raſh adjuration with-held the Iſraelites from eating, which being taſted, not only gratified the taſte, but enlightned the eyes.

1 Sam. xiv. ver. 27, 29.

Now theſe allegations againſt the ſcripture we are to examine being but too various, it will be requiſite for us to conſider the ſtyle of it, not in the ſtricter acceptation, wherein an author's ſtyle is wont to ſignify the choice and diſpoſition of his words, but in that larger ſenſe, wherein the word ſtyle comprehends not only the phraſeology, the tropes and figures made uſe of by a writer, but his method, his lofty or humbler character (as orators ſpeak) his pathetical or languid, his cloſe or incoherent way of writing; and in a word, almoſt all the whole manner of an author's expreſſing himſelf.

WHEREFORE, though the title of an eſſay prefixed to this treatiſe will, I preſume, invite you to expect from me rather ſome looſe conſiderations than any full and methodical diſcourſe concerning the ſtyle of the ſcripture; yet I hope you will not think it ſtrange, if ſo comprehenſive a theme make this part of the eſſay diſproportionate to the others; eſpecially ſince the nature of your commands, and that of my deſign, oblige me to interweave ſome other things with thoſe that more directly regard the ſtyle of the ſcripture, and particularly to lay hold on all opportunities I can diſcreetly take, to invite you to ſtudy much, and highly to eſteem a book, which there is no danger you can too much ſtudy, or eſteem too highly.

IT has been a common ſaying among the ancients, that even *Jupiter* could not pleaſe all. But by the objections I meet with againſt the ſcripture, I find, that the true God himſelf is not free from the imputation of his audacious creatures, who impiouſly preſume to quarrel as well with his revelations as his providence, and expreſs no more reverence to what he hath dictated than to what he doth. For not now to mention what is by atheiſts and antiſcripturiſts alledged to overthrow the truth and authority of the ſcripture, (becauſe it is not here, but elſewhere, that we are to deal with that ſort of men) even by ſome of thoſe, that acknowledge both, (for with ſuch only we have now to reaſon) there are I know not how many faults found with the ſtyle of the ſcripture. For ſome of them are pleaſed to ſay, that book is too obſcure; others, that it is immethodical; others, that it is contradictory to itſelf; others, that the neighbouring parts of it are incoherent; others, that it is unadorned; others, that it is flat and unaffecting; others, that it abounds with things, that are either trivial or impertinent, and alſo with uſeleſs repetitions. And indeed ſo many and ſo various are the faults and imperfections imputed by theſe men to the ſcripture, that my wonder at them would be almoſt as great as is my trouble, if I did not conſider, how much it is the intereſt of the great adverſary of mankind, and eſpecially of (that choiceſt part of it) the church, to depreciate compoſures, that if duly reverenced would prove ſo deſtructive to his kingdom and deſigns; and if I did not alſo remember, that (ſuch is the querulous and exceptious nature of men) it was *Cicero* himſelf that obſerved, *Vitari non poſſe reprehenſionem, niſi nihil ſcribendo*. But as poets and aſtronomers have fancied, among the celeſtial lights, that adorn the firmament, bears, bulls, goats, dogs, ſcorpions, and other beaſts; ſo our adverſaries impute I know not what imaginary deformities to a book, ennobled by its author with many celeſtious lights, fit to inſtruct the world, and diſcover to them the ways of truth and bleſſedneſs. Although, I ſay, this be ſo, yet ſince the miſrepreſentation made by theſe men of the Bible is not inferiour to that made by poets and coſmographers of the firmament; I hope you will be as little deterred by the moſt diſparaging imputations from ſtudying the ſcripture, as pilots are by the name of *bear* given to the moſt northern conſtellation, from having their eyes upon the pole-ſtar, and ſteering their courſes by it.

AND ſince you will eaſily believe, that a perſon ſo averſe from wrangling as I, is not like to make the diſputing with theſe cenſures of the ſcripture-ſtyle, any further his deſign, than as the invalidating their objections conduces to the reputation of that ſacred book; I preſume you will not think it at all impertinent, if oftentimes I intermix with thoſe things, that more directly regard ſuch objections, other things, that ſeem to tend rather to celebrate than vindicate the ſcripture. For in ſo doing, I hope I ſhall not alone conſiderably, though not perhaps ſo directly, ſtrengthen my anſwers, by ſhewing that we juſtly aſcribe to the ſcripture qualities quite oppoſite to the imperfections imputed to it; but I ſhall perfectly comply with my main deſign, which I here declare, once for all, is but to engage you to ſtudy and value the ſcripture, and therefore obliges me to anſwer objections only ſo far forth, as they may look like arguments to diſſuade you from prizing and ſtudying it. And becauſe I find not, that the objections to be conſidered have any great coherence with, or dependence on each other, I ſhall not ſcruple to mention them, and my reflections on them, in no other order, than that wherein they ſhall chance to occur to my thoughts whilſt I am writing.

OF the conſiderations then, that I am to lay before you, there are three or four, which are of a more general nature; and therefore being ſuch as may each of them be pertinently employed againſt ſeveral of the exceptions taken at the ſcripture's ſtyle, it will not be inconvenient to mention them before the reſt.

AND, in the firſt place, it ſhould be conſidered, that thoſe cavillers at the ſtyle of the ſcripture, that you, and I have hitherto met with, do (for want of ſkill in the original) eſpecially in the Hebrew, judge of it by the tranſlations, wherein alone they read it. Now ſcarce any but a linguiſt will imagine, how much a book may loſe of its elegancy, by being read in another tongue than that it was written in; eſpecially if the languages, from which, and into which, the verſion is made, be ſo very differing, as are thoſe of the eaſtern and theſe weſtern parts of the world. But of this I foreſee an occaſion of ſaying ſomething hereafter; yet at preſent I muſt obſerve to you, that the ſtyle of the ſcripture is much more diſadvantaged, than that of other books, by being judged of by tranſlations. For the religious and juſt veneration, that the interpreters of the Bible have had for that ſacred book, has made them, in moſt places, render the Hebrew and Greek paſſages ſo ſcrupulouſly word for word, that for fear of not keeping cloſe enough to the ſenſe, they uſually care not how much they loſe of the eloquence of the paſſages they tranſlate. So that, whereas in thoſe verſions of other books, that are made by good linguiſts, the interpreters are wont to take the liberty to recede from the author's words, and alſo ſubſtitute other phraſes inſtead of his, that they may expreſs his meaning, without injuring his reputation; in tranſlating the Old Teſtament, interpreters have not put Hebrew phraſes into Latin or Engliſh phraſes, but only into Latin or Engliſh words; and have too often beſides, by not ſufficiently underſtanding, or at leaſt conſidering, the various ſignifications of words, particles, and tenſes in the holy tongue, made many things appear leſs coherent, or leſs rational, or leſs conſiderable, which, by a more free and ſkilful rendering of the original, would not be blemiſhed by any appearance of ſuch imperfection. And though this fault of interpreters be pardonable enough in them, as carrying much of its excuſe in its cauſe; yet it cannot but much derogate from the ſcripture, to appear with peculiar diſadvantages, beſides thoſe many, that are common to almoſt all books, by being tranſlated.

FOR whereas the figures of rhetoric are wont, by orators, to be reduced to two comprehenſive ſorts; and one of thoſe does ſo depend upon the ſound and placing of the words (whence the Greek rhetoricians call ſuch figures σχήματα λέξεως) that, if they be altered, though the ſenſe be retained, the figure may vaniſh; this ſort of figures, I ſay, which comprizes thoſe that orators call *Epanados*, *Antanaclaſis*, and a multitude of others, are wont to be loſt in ſuch literal tranſlations as are ours of the Bible, as I could eaſily ſhow by many inſtances, if I thought it requiſite.

BESIDES, there are in Hebrew, as in other languages, certain appropriated graces, and a peculiar emphaſis belonging to ſome expreſſions, which muſt neceſſarily be impaired by any tranſlation, and are but too often quite loſt in thoſe, that adhere too ſcrupulouſly to the words of the original. And, as in a lovely face, though a painter may well enough expreſs the cheeks, and the noſe, and lips; yet there is often ſomething of ſplendour and vivacity in the eyes, which no pencil can reach to equal: ſo, in ſome choice compoſures, though a ſkilful interpreter may happily enough render into his own language a great part of what he tranſlates, yet there may well be ſome ſhining paſſages, ſome ſparkling and emphatical expreſſions, that he cannot poſſibly repreſent to the life. And this conſideration is more applicable to the Bible and its tranſlations, than to other books, for two particular reaſons.

FOR firſt, it is more difficult to tranſlate the Hebrew of the Old Teſtament, than if that book were written in Syriack, or Arabick, or ſome ſuch other eaſtern language. Not that the holy tongue is much more difficult to be learned than others; but becauſe in the other learned tongues, we know there are commonly variety of books extant, whereby we may learn the various ſignifications of the words and phraſes; whereas the pure Hebrew being unhappily loſt, except ſo much of it as remains in the Old Teſtament, out of whoſe books alone we can but very imperfectly frame a dictionary and a language; there are many words, eſpecially the ἅπαξ λεγόμενα, and thoſe that occur but ſeldom, of which we know but that one ſignification, or thoſe few acceptions, wherein we find it uſed in thoſe texts, that we think we clearly underſtand. Whereas, if we conſider the nature of the primitive tongue, whoſe words being not numerous, are moſt of them equivocal enough, and do many of them abound with ſtrangely different meanings; and if we conſider too, how likely it is, that the numerous conqueſts of *David*, and the wiſdom, proſperity, fleets, and various commerces of his ſon *Solomon*, did both enrich and ſpread the Hebrew language, it cannot but ſeem very probable, that the ſame word or phraſe may have had divers other ſignifications, than interpreters have taken notice of, or we are now aware of: ſince we find in the Chaldee, Syriack, Arabick, and other eaſtern tongues, that the Hebrew words and phraſes (a little varied, according to the nature of thoſe dialects) have other, and oftentimes, very different ſignifications, beſides thoſe, that the modern interpreters of the Bible have aſcribed to them. I ſay, the modern, becauſe the ancient verſions before, or not long after our Saviour's time, and eſpecially that which we vulgarly call the Septuagint's, do frequently favour our conjecture, by rendring Hebrew words and phraſes to ſenſes very diſtant from thoſe more received ſignifications in our texts; when there appears no other ſo probable reaſon of their ſo rendring them, as their believing them capable of ſignifications differing enough from thoſe, to which our later interpreters have thought fit to confine themſelves. The uſe, that I would make of this conſideration, may eaſily be conjectured, namely, that it is probable, that many of thoſe texts, whoſe expreſſions, as they are rendred in our tranſlations, ſeem flat, or improper, or incoherent with the context, would appear much otherwiſe, if we were acquainted with all the ſignifications of words and phraſes, that were known in the times, when the Hebrew language flouriſhed, and the ſacred books were written; it being very likely, that among thoſe various ſignifications, ſome one or other would afford a better ſenſe, and a more ſignificant and ſinewy expreſſion, than we meet with in our tranſlations; and perhaps would make ſuch paſſages, as ſeem flat or uncouth, appear eloquent and emphatical. Whilſt I am writing this, our Engliſh tongue preſents to my thoughts an example, which may ſeem to illuſtrate much of the foregoing conſideration: and it is this; that though, as one would eaſily believe, there are but a few forms of ſpeaking, which relate to the birth of infants, yet there are five or ſix expreſſions concerning that one affair, wherein very peculiar and unwonted notions belong to the words and phraſes: for, if I ſay, that ſuch a woman has looked every hour theſe ten days; that yeſterday ſhe cried out; that ſhe had a quick and eaſy labour; that laſt night ſhe was brought-to-bed; that now ſhe lies-in; and, that it is fit we ſhould remember the lady in the ſtraw: if, I ſay, I make uſe of any or all of theſe expreſſions, an Engliſhman would readily underſtand me; but if I ſhould literally, and word for word, tranſlate them, I ſay, not into Greek or Hebrew, but into the languages of our neighbour-nations, French or Italian, men would not underſtand what I mean. And if a diſcourſe, wherein they were employed, were tranſlated by an interpreter only acquainted with the genuine and more obvious ſignification of the Engliſh word, it would, in ſuch paſſages, appear very diſadvantageouſly, and perhaps be thought impertinent, or nonſenſical, to a French or Italian reader.

BUT this is not all; for I conſider in the ſecond place, that not only we have loſt divers of the ſignifications of many of the Hebrew words and phraſes, but that we have alſo loſt the means of acquainting ourſelves with a multitude of particulars relating to the topography, hiſtory, rites, opinions, faſhions, cuſtoms, &c. of the antient Jews and neighbouring nations, without the knowledge of which we cannot, in the peruſing of books of ſuch antiquity, as thoſe of the Old Teſtament, and written by and (principally) for Jews; we cannot, I ſay, but loſe very much of that eſteem, delight, and reliſh, with which we ſhould read very many paſſages, if we diſcerned the references and alluſions, that are made in them to thoſe ſtories, proverbs, opinions, *&c.* to which ſuch paſſages may well be ſuppoſed to relate. And this conjecture will not, I preſume, appear irrational, if you but conſider, how many of the handſomeſt paſſages in *Juvenal*, *Perſius*, *Martial*, and divers other Latin writers, (not to mention *Heſiod*, *Muſæus*, or other antienter Greeks) are loſt to ſuch readers, as are unacquainted with the Roman cuſtoms, government, and ſtory; nay, or are not ſufficiently informed of a great many particular circumſtances, relating to the condition of thoſe times, and of divers particular perſons pointed at in thoſe poems. And therefore it is, that the latter critics have been fain to write comments, or at leaſt notes, upon every page, and in ſome pages upon almoſt every line of thoſe books, to enable the reader to diſcern the eloquence, and reliſh the wit of the author. And if ſuch dilucidations be neceſſary to make us value writings, that treat of familiar and ſecular affairs, and were written in an European language, and in times and countries much nearer to ours; how much do you think we muſt loſe of the elegancy of the book of *Job*, the Pſalms of *David*, the Song of *Solomon*, and other ſacred compoſures, which not only treat oftentimes of ſublime and ſupernatural myſteries, but were written in very remote regions ſo many ages ago, amidſt circumſtances, to moſt of which we cannot but be great ſtrangers? And thus much for my firſt general conſideration.

MY ſecond is this, That we ſhould carefully diſtinguiſh betwixt what the ſcripture itſelf ſays, and what is only ſaid in the ſcripture. For we muſt not look upon the Bible as an oration of God to men, or as a body of laws, like our Engliſh ſtatute book, wherein it is the legiſlator, that all the way ſpeaks to the people; but as a collection of compoſures of very differing ſorts, and written at very diſtant times; and of ſuch compoſures, that though the holy men of God (as St. *Peter* calls them) were acted by the Holy Spirit, who both excited and aſſiſted them in penning the ſcripture, yet there are many others, beſides the author and the penmen, introduced ſpeaking there. For beſides the books of *Joſhua*, *Judges*, *Samuel*, *Kings*, *Chronicles*, the four evangeliſts, *the Acts of the Apoſtles*, and other parts of ſcripture that are evidently hiſtorical, and wont to be ſo called; there are, in the other books, many paſſages, that deſerve the ſame name, and many others, wherein, though they be not meer narratives of things done, many ſayings and expreſſions are recorded, that either belong not to the author of the ſcripture, or muſt be looked upon as ſuch, wherein his ſecretaries perſonate others. So that, in a conſiderable part of the ſcripture, not only prophets, and kings, and prieſts being introduced ſpeaking, but ſoldiers, ſhepherds, and women, and ſuch other ſorts of perſons, from whom witty or eloquent things are not (eſpecially when they ſpeak *ex tempore*) to be expected, it would be very injurious to impute to the ſcripture any want of eloquence, that may be noted in the expreſſions of others, than its author. For though, not only in romances, but in many of thoſe that paſs for true hiſtories, the ſuppoſed ſpeakers may be obſerved to talk as well as the hiſtorian; yet that is, but either becauſe the men ſo introduced were ambaſſadors, orators, generals, or other eminent men for parts, as well as employments; or becauſe the hiſtorian does, as it often happens, give himſelf the liberty to make ſpeeches for them, and does not ſet down indeed what they ſaid, but what he thought fit that ſuch perſons, on ſuch occaſions, ſhould have ſaid. Whereas the pen-men of the ſcripture, as one of them truly profeſſes, having not followed cunningly deviſed fables in what they have written, have faithfully ſet down the ſayings, as well as actions, they record, without making them rather congruous to the conditions of the ſpeakers, than to the laws of truth.

NOR is it only the ſtyle of very many paſſages of ſcripture, that may be juſtified by our ſecond conſideration; but, with the ſame diſtinction well applied, we may ſilence ſome of their malicious cavils, who accuſe the ſcripture of teaching vice by the ungodly ſayings and examples, that are here and there to be met with in it. But, as the Apoſtle ſaid, that *they are not all Iſrael, that are of Iſrael*; ſo we may ſay, Rom. ix. 6. that is not ſcripture, that is in the ſcripture: for many wicked perſons, and their perverter Satan, are there introduced, whoſe ſayings the Holy Ghoſt doth not adopt, but barely regiſters; nor does the ſcripture affirm, that what they ſaid was true, but that it is true they ſaid it. And if I had not reduced ſome of thoſe cavillers to confeſs, that they never did themſelves read thoſe pieces of the Bible, at ſome of whoſe paſſages they cavil, I ſhould much more admire than I do, to find them father, as confidently as they do all they hear cited from it, upon the enditer of it; as if the devil's ſpeeches were not recorded there, and as if it were requiſite to make a hiſtory divinely inſpired, that all the blaſphemies and crimes it regiſters ſhould be ſo too. As for the ills recorded in the ſcripture, beſides that wicked perſons were neceſſary to exerciſe God's children, and illuſtrate his providence; and, beſides the allegations commonly made on that ſubject, we may conſider, that there being many things to be declined, as well as practiſed, 'twas fit we ſhould be taught as well what to avoid, as what to imitate; and the known rocks and ſhelves do as well guide the ſeamen, as the pole-ſtar. Now, as we could not be armed againſt the tempter's methods, if we ignored them, ſo could we never ſafelier nor better learn them, than in his book, who can alone diſcover the wiles, and fathom the *depths of Satan*, and Rev. ii. 24. track him through all his windings, and (otherwiſe untraceable) labyrinths; and in that book, where the antidote is exhibited with the poiſon, and either mens defeat or victory may teach us, at others coſts, and without our hazard, the true art of what warfare we are all ſo highly concerned in. And, as chymiſts obſerve in the book of nature, that thoſe ſimples, that wear the figure or reſemblance (by them termed ſignature) of a diſtempered part, are medicinal for that part of that infirmity, whoſe ſignature they bear; ſo, in God's other book, the vicious perſons there mentioned ſtill prove, under ſome notion, or upon ſome ſcore or other, antidotal againſt the vices notorious in them, being (to preſent it you alſo in a ſcripture ſimile) like the brazen ſerpent in the wilderneſs, ſet up to cure the poiſon infuſed by thoſe they reſemble. *Whatſoever things were written afore-time*, ſays the Apoſtle, *were written* Rom. xv. 4. *for our inſtruction*. And, to make further uſe of our former compariſon, thoſe, to whom the ſcripture gives the names of lions, wolves, foxes, and other brutes, by God's aſſiſtance, prove to his ſaints as inſtructive beaſts, as doth the northern bear unto the wandering pilot. And, as antiently God fed his ſervant *Elias*, ſometimes by an angel, ſometimes by a woman, and ſometimes too by ravens, ſo doth he make all perſons in the Bible, whether good, or bad, or indifferent, ſupply his ſervants with that inſtruction, which is the aliment of virtue, and of ſouls, and makes them and their examples contribute to the verification of that paſſage of St. *Paul*, wherein he ſays, that *all things co-operate for good to them that love God*. Rom. viii. 28.

MY third conſideration is this: That the ſeveral books of the Bible were written chiefly and primarily to thoſe, to whom they were firſt addreſſed, and to their contemporaries; and that yet the Bible not being written for one age of people only, but for the whole people of God, conſiſting of perſons of all ages, nations, ſexes, complexions and conditions, it was fit it ſhould be written in ſuch a way, as that none of all theſe might be quite excluded from the advantages deſigned them in it. Therefore were theſe ſacred books ſo wiſely, as well as graciouſly, tempered, that their variety ſo comprehends the ſeveral abilities and diſpoſitions of men, that (as ſome

pictures ſeem to have their eyes directly fixed on every one that looks on them, from what part ſoever of the room he eyes them) there is ſcarce any frame of ſpirit a man can be of, or any condition he can be in, to which ſome paſſage of ſcripture is not as patly applicable, as if it were meant for him, or ſaid to him as *Nathan* once did to
2 Sam. xii. 7. *David*, *Thou art the man.* What has been thus obſerved touching God's deſign in the contrivance of the ſcripture, may aſſiſt us to defend the ſtyle of a great multitude of its texts, and particularly of divers of thoſe, which belong to the five following kinds.

AND firſt, the ſeveral books, that make up the canon of the Scripture, being primarily deſigned for their uſe, that lived in the times wherein they were divulged, it need be no wonder, if each of them contain many things, that principally concern the perſons that then lived, and be accordingly written in ſuch a way that many of its paſſages allude, and otherwiſe relate to particular times, places, perſons, cuſtoms, opinions, ſtories, *&c.* which, by our formerly-mentioned want of a good account of ſuch remote ages and regions, cannot afford us that inſtruction and ſatisfaction, that thoſe, to whom ſuch books were immediately addreſſed, might eaſily derive from the peruſal of them.

NEXT, as ſome portions of ſcripture were principally deſigned for ages very long ſince paſt, ſo ſome other parts of it, eſpecially thoſe that are yet prophetick, may probably reſpect future times, much more than ours: and our poſterity may admire what we cannot now reliſh, becauſe we do not yet underſtand it. Moreover, there being many portions of ſcripture, as almoſt the whole four laſt books of *Moſes*, wherein God is introduced as either immediately, or mediately giving laws to his people, or his worſhippers, I ſuppoſe it will not be thought neceſſary, that ſuch parts of ſcripture ſhould be eloquently written, and that the ſupreme legiſlator of the world, who reckons the greateſt kings amongſt his ſubjects, ſhould, in giving laws, tye himſelf to thoſe of rhetorick; the ſcrupulous obſervation of which would much derogate from thoſe two qualities, ſo conſiderable in laws, clearneſs and majeſty.

1 Pet. i. 12. BESIDES, there being a ſort of men, of which I hope the number will daily encreaſe, who have ſuch a deſire, as St. *Peter* tells us the angels themſelves cheriſh, to look into the myſteries of religion, and are qualified with elevated and comprehenſive intellects, to apprehend them in ſome meaſure; it is not unfit, that to exerciſe ſuch mens abilities, and to reward their induſtry, there ſhould be ſome abſtruſe texts of ſcripture fitted to the capacities of ſuch ſpeculative wits, and above the reach of vulgar apprehenſions.

AND, on the other ſide, the omniſcient Author of the ſcripture foreſeeing, that it would follow from the condition of mankind, that the greateſt part of the members of the church would be no great clerks, and many of them very weak or illiterate, it was but ſuitable to his goodneſs, that a great many other paſſages of the books deſigned for them, as well as others, ſhould be written in ſuch a plain and familiar way, as may befit ſuch readers, and let them ſee, that they were not forgotten, or
Ezek. xviii. 4. overlooked by him, who truly ſays, by the prophet, that *all ſouls are his.* And yet in many, even of theſe texts, which ſeem chiefly to have been deſigned to teach the ſimple, ſcholars themſelves may find much to learn. For not only there are ſome paſſages, that contain milk for babes, and others, that exhibit ſtrong meat for riper ſtomachs, but oftentimes (as cows afford both milk and beef) the ſame texts, that babes may ſuck milk from, ſtrong men may find ſtrong meat in: the ſcripture itſelf in ſome ſenſe fulfilling the promiſe made us in it, that *Habenti dabitur (to him that hath ſhall be given)* and being like a fire, that ſerves moſt men but to warm, and

dry themſelves, and dreſs their meat, but ſerves the ſkilful chymiſt to draw quinteſſences and make extracts.

I DOUBT not but you are acquainted as well as I with divers querulous readers, who very boldly find fault with this variety, wherein God hath thought fit to exhibit his truth, and declare his will in holy writ, and preſume to cenſure ſome texts as too myſterious, very many as too plain. But theſe exceptions at the oeconomy of the ſcripture do commonly proceed from their pride, that make them; for that vice, inclining them to fancy, that the Bible either was or ought to have been written purpoſely for them, prompts them to make exceptions ſuitable to ſuch a preſumption; and, whilſt they look upon their own abilities as the meaſure of all diſcourſes, to call all that tranſcends their apprehenſions, dark, and all that equals it not, trivial. They will be always finding fault with the Holy Ghoſt's expreſſions, both where his condeſcenſions make them clear, and where the ſublimity of the matter leaves them obſcurer; like bats, whoſe tender eyes love neither day nor night, and are only pleaſed with (what is alone proportioned to their weak ſight) a twilight, that is both or neither. But as a ſkilful fowler (and the compariſon will be excuſed by thoſe, that remember that God in ſcripture is ſaid to be preſſed as a *cart is preſſed that is full of ſheaves*, and the ſon of man to be as *a thief in the night)* according to the differing natures of his game, ſo contrives and appropriates his ſtratagems, that ſome he catches with light, (as larks with day-nets) ſome with baits, (as pigeons with peas) ſome with frights, (as black-birds with a ſparrow-hawk or low-bell) and ſome he draws in with company (as ducks and ſuch like ſocial birds with decoy-fowl): ſo God knowing that ſome perſons muſt be wrought upon by reaſon, others allured by intereſt, ſome driven in by terrour, and others again brought in by imitation, hath by a rare and merciful (if I may ſo call it) ſuppleneſs of wiſdom ſo varied the heavenly doctrine into ratiocinations, myſteries, promiſes, threats and examples, that there is not any ſort of people, that in the ſcripture may not find religion repreſented in that form they are moſt diſpoſed to receive impreſſions from; God therein graciouſly dealing with his children not unlike the prophet, that ſhrunk himſelf into the proportion of the child he meant to revive. The genius's, the capacities and the diſpoſitions of men are ſo diſtinct, and oftentimes ſo extravagant, that there is ſcarce a paſſage of ſcripture, that is not ſuitable or appropriate to ſome of thoſe numberleſs differences of humour the Bible was deſigned for; and in that unimaginable variety of occurrences ſhared amongſt ſuch vaſt multitudes, finds not a proper object. And therefore God, who (having created them) beſt knows the frame of mens ſpirits, having been pleaſed to match them with proper texts; I ſhall not quarrel with his vouchſafing to liſp myſteries to thoſe, that would be deterred by any other way of expreſſing them, and to qualify his inſtruments according to the natures he deſigns them to work upon, leſt he ſhould ſay to me with the houſe-holder in the goſpel, *Is thine eye evil, becauſe I am good?* And ſure it muſt extremely miſbecome us to repine at the greatneſs of God's condeſcenſions, only upon the ſcore of a knowledge or attainments that we owe to it.

Amos xi. 15.

2 Kings iv. 34.

BY reflecting upon the three foregoing general conſiderations, you will, I preſume, eaſily perceive, what it is that is pretended to in what I repreſent to you in the behalf of the ſcripture. For you will eaſily gueſs, by what I have hitherto told you, I pretend not to prove or aſſert, that every text of ſcripture, eſpecially in tranſlations, is embelliſhed with the ornaments of rhetorick, but only to ſhew theſe two things; the one, that as there may be drawn from divers things in the ſcripture it ſelf (without excluding the ſtyle) conſiderable arguments of its having been written or approved by men peculiarly aſſiſted by the ſpirit of God; ſo if a man be perſuaded either by theſe intrinſick arguments, (which I may in another paper evince to be no ſlight ones) or by any others, of the heavenly origination of the ſcripture; if, I ſay, a man be perſuaded of this, he ought not in reaſon by the ſtyle of theſe books to be kept from diligently ſtudying of them, and highly valuing them. The other (which I add as one evincement of the former) is, that not only the ſcripture is every where written with as much eloquence as the chief author (whoſe omniſcience qualified him to judge beſt in the caſe) thought fit and expedient, as we now have the ſacred books, eſpecially in their originals, very many paſſages of them are ſo far from being deſtitute of what even our weſtern nations count eloquence, that they deſerve to be admired for it. And, *Theophilus*, if you pleaſe to keep in your eye what I have now told you concerning my ſcope in writing, and to bear in your memory the three general conſiderations I have premiſed, I ſhall need hereafter, as often as I have occaſion to mention them, only to point at them; and thereby ſhall excuſe you and my ſelf from the unwelcome trouble of many times repeating the ſame things.

To proceed then to the more particular objections againſt the ſcripture, the firſt I ſhall conſider is, that it is obſcure. And this I find alledged by two ſort of men to two differing purpoſes; ſome endeavouring by it to diſgrace the Bible, and others only making the pretended darkneſs of many of its paſſages an excuſe for their not ſtudying it.

To the firſt ſort of objectors I anſwer, that it is little leſs than inevitable, that many paſſages of the ſcripture ſhould ſeem obſcure to us, and that it is but fit, that divers others ſhould be ſo too.

FOR firſt, the objectors, as I formerly obſerved, reading the Bible but in tranſlations, are deſtitute of thoſe helps to underſtand the ſenſe of many paſſages, that may be afforded by ſkill in the original languages. Beſides, that even to thoſe, that have taken pains to underſtand the original tongues, the genuine ſenſe of divers words and phraſes is denied by the injury of time, through which (as was already noted) a great part of the Hebrew and Chaldean tongues have been loſt.

2dly, MANY texts appear obſcure to thoſe, that live in theſe latter times, only becauſe that by reaſon of the periſhing of thoſe writings and other monuments of antiquity, that were contemporary to the books of the old teſtament, we cannot be ſufficiently acquainted with the hiſtory, the laws and cuſtoms of the *Jews*, and other nations mentioned in the ſcripture; ſo that it need be no wonder if divers paſſages of the books of *Geneſis*, *Joſhuah*, *Judges*, *Samuel*, the *Kings*, *Heſter*, and other hiſtorical books of the ſcripture, as alſo of the four laſt books of *Moſes*, are obſcure to us; and yet might be very intelligible to thoſe, in whoſe times they were written, and for whoſe uſe they were principally deſigned. As although *Lucius Florus* would in many places appear very obſcure to ſuch readers, as know nothing of the Roman affairs, but by the account given of them in his writing, (whence divers late criticks have been invited to illuſtrate him out of other Latin authors) yet queſtionleſs to the Roman readers, that lived in his time, or not very long after, his book was eaſy enough to be underſtood. How much the want of other hiſtorians, contemporary to the penmen of the old teſtament, may make things ſeem obſcure, that might by ſuch ſtories be eaſily cleared up, we may obſerve from divers paſſages of the new teſtament, which can ſcarce be well underſtood without an account of *Herod*'s family, and the changes that happened about our Saviour's time in *Judæa*, which was ſometimes all of it governed by *Herod* the great, that maſſacred the children of *Bethlehem*, and ſometimes was governed by *Pilate* and other Roman magiſtrates; and ſometimes was ſo divided, that it was as to ſome parts only governed by *Herod*'s deſcendants under various titles; the want of the knowledge of which, and of the ſeveral princes that bore the name of *Herod*, does much puzzle many readers, that are ſtrangers to *Joſephus*.

And it ſeems ſomewhat ſtrange to many, that Chriſt ſhould in St. *Luke* admoniſh his hearers to fly out of *Jeruſalem* and *Judæa*, and not reſort thither from the neighbouring countries, when they ſhould ſee *Jeruſalem* encompaſſed with armies, ſince thoſe armies would probably hinder the counſelled retirement (at leaſt as to the city). Whereas he that finds in the ſtory, that the Roman forces under *Gratus* did on a ſudden, and (as good authors tell us) without any manifeſt cauſe, withdraw from the ſiege of *Jeruſalem*, and then return to it again, and (under *Titus*) carry the town by force; he that ſhall read alſo in *Euſeb. lib. 3. cap.* 5. that the Chriſtians of *Jeruſalem* did (divinely admoniſhed) make uſe of the opportunity preſented them to quit all of them the city, and retire to *Pella* on the other ſide of *Jordan*; he, I ſay, that ſhall read and take notice of all this, will not only clearly underſtand the reaſonableneſs of our Saviour's warning, but admire the prophetical ſpirit by which he could give it. And as it is difficult to collect out of the old teſtament alone the hiſtory of thoſe times, wherein it was written; ſo it is not to be expected, that out of thoſe books we ſhould be able to collect and comprehend, either complete ideas of the Iſraelitiſh government, civil and eccleſiaſtical, or the true ſtate of their ſeveral ſects, opinions and affairs in matters of religion: and yet without the knowledge of thoſe it cannot be, but that many texts will ſeem obſcure to us, which were not at all ſo to them, that were coætaneous to the pen-men of thoſe books. The labours of ſome modern criticks, that have put themſelves to the trouble of making a thorough ſearch into the writings of thoſe Jewiſh Rabbies, that lived about our Saviour's and his Apoſtles times, have, by the help of the rabbinical learning, already cleared up divers texts, which before were dark, becauſe they related to particular ſects, cuſtoms, ſayings, or opinions amongſt the then Jews, whoſe knowledge, the writers of the new teſtament do not teach, but ſuppoſe. And I doubt not, but higher and valuable attainments in that kind of learning (how worthleſs ſoever I ſhould think it, if it were not conducive to the illuſtration of the ſcripture) will, ere it be very long, diſperſe that obſcurity, which yet dwells upon divers other texts, and will ſhew the groundleſſneſs of all our cavils at them, as well as that of many of our too fierce contentions about them. I ſhall add, that I dare almoſt preſume to queſtion, whether even our famouſeſt critics have not left divers Moſaical texts in the dark, if not clouded them by their comments, merely for want of knowing the religion of the antient Zabians, in oppoſition of whoſe magical worſhip and ſuperſtitions, I am apt to think divers ceremonies of the ritual law of the Jews to have been inſtituted. And yet of thoſe Zabiiſts (or צביים and صابئين as the Hebrews and Arabians expreſs the name) I find a deep and general ſilence in claſſic authors, except (the Rabbi's oracle) *Maimonides*, out of whom our great antiquary (Mr. *Selden)* both in familiar diſcourſe, and in his excellent tract of the Syrian deities, gave me firſt a hint, which by lighting on another author of thoſe parts, I have ſince had the luck to improve ſufficiently, to make me fear, that they, who are ſtrangers to the Zabians rites and creed, will ſcarce give us the cleareſt account the theme is capable of in divers paſſages of the Moſaick law. As I am apt to think, that our ignorance or want of taking notice of the perſuaſions and practices of the Gnoſticks, Carpocratians, and the ſects allied to theirs, if it do not make us miſtake and miſinterpret, doth at leaſt keep us from giving the cleareſt interpretations, whereof they are capable, to many paſſages of the New Teſtament, wherein they are either clearly pointed at, or cloſely related to.

Luke xxi. 21, 22.

3. We may reaſonably ſuppoſe, that of the texts, that are now difficult unto us, there are divers that are ſo, but becauſe they were principally intended for the uſe of thoſe that ſhall live in after-times, by whom they will queſtionleſs be better underſtood. To the Jews, that lived in and along after *Moſes* his time, many of thoſe predictions, both verbal and typical, of the Meſſias, ſeemed very dark, which to us

Chriſtians are abundantly illuſtrated by the riſing of that ſun of righteouſneſs, who was aimed at in them. And though the myſterious temple and city deſcribed in *Ezekiel*, as alſo much of the Apocalypſe, and divers other prophetick paſſages of holy writ, do yet ſeem abſtruſe to us; yet they will not appear ſo to thoſe, to whom their completion (the beſt expoſitor of dark prophecies) ſhall have unfolded them. For I obſerve, that as ſome divine predictions are clearly expreſſed, to the intent that thoſe, that are made acquainted with them, may before-hand know what will happen, ſo others are propoſed, not ſo much that thoſe, to whom they are firſt addreſſed, ſhould know the fore-told events, before they do come to paſs, as that, when they do come to paſs, the ſame accompliſhment, that expounds them, may evince, that the foreteller of them was able to foreſee them, according to that of our Saviour to his diſciples, to whom he propheſied the ſufferings they ſhould undergo; *Theſe things have I told you, that when the time ſhall come, ye may remember that I told you of them.* John xxvi. 4.

4. IT was fit, that there ſhould be ſome obſcure paſſages left in the inſpired volume, to keep thoſe from the knowledge of ſome of thoſe divine myſteries, that are both delightful and uſeful, though not abſolutely neceſſary, who do not think ſuch knowledge worth ſtudying for. As it was alſo fit (which I partly noted above) that there ſhould be ſome clouded and myſterious texts, to excite and recompence the induſtry and ſpeculation of elevated wits and religious inquirers.

Laſtly, THERE are divers obſcure paſſages in ſcripture, wherein the difficulty lies in the thing it ſelf that is expreſſed, not in the ſcripture's manner of expreſſing it. For not to mention that obſcureneſs, that is wont to attend prophetick raptures, (of which there are many mentioned in the ſcripture) there are divers things, that we agree to be knowable by the bare light of nature without revelation, which yet are ſo uneaſy to be ſatisfactorily underſtood by our imperfect intellects, that let them be delivered in the cleareſt expreſſions men can deviſe, the notions themſelves will yet appear obſcure. Thus in natural philoſophy it ſelf, the nature of place and time, the origin of motion, and the manner whereby the human ſoul performs her functions, are things, which no writers delivered ſo clearly, as not to leave the things ſomewhat obſcure to inquiſitive and examining readers. And ſhall we then wonder, that thoſe texts of ſcripture, that treat of the nature and decrees of God, and of ſuch ſublime myſteries as the trinity, the incarnation, the influence of the ſpirit upon the ſoul of man, and ſuch other abſtruſe things, which it cannot be reaſonably expected that human words ſhould keep from being hard to be comprehended by human underſtanding, ſhould be obſcure to us; eſpecially if we ſuffer our not underſtanding their full meaning at firſt to deter us from endeavouring to find it out by further ſtudy. I am ſorry I can add on this occaſion, that divers texts are made to appear more dark, than otherways they would, by the gloſſes and interpretations of ſome, that pretend to expound them. For there are divers ſubtle men, who being perſuaded, upon certain metaphyſical notions they are fond of, or by the authority of ſuch either churches or perſons as they highly reverence, that ſuch or ſuch niceties are either requiſite to the explication of this, or that doctrine delivered in ſcripture, or, at leaſt, deducible from it, will make bold ſo to interpret dark texts, (and ſometimes even clear ones) that they ſhall ſeem to hold forth, not only their own ſenſe, but the nice ſpeculations, or deductions of him that quotes them: ſo that divers texts, which, to a rational and unprepoſſeſſed peruſer, would appear plain enough, ſeem to contain inextricable difficulties to thoſe unwary or prejudicate who are not careful to diſtinguiſh betwixt the plain ſenſe of the text itſelf, and thoſe metaphyſical ſubtleties, which witty and intereſted perſons would father upon it; though oftentimes thoſe niceties are either ſo groundleſs, that though there needs much wit to deviſe them, there needs but a little reaſon to deſpiſe them;

or ſo unintelligible, as to tempt a conſidering man to ſuſpect, that the propoſers either mean not what they ſpeak, or underſtand not what they ſay. And I could wiſh theſe metaphyſical quirks, with which ſeveral, not only ſchool-men, but other writers, have perplexed the doctrine of predeſtination, of the trinity, of the operation of the ſpirit of God upon the will of man, and ſome other myſteries of Chriſtian religion, did not give advantages againſt thoſe doctrines to the oppoſers of them, and perhaps make ſome men oppoſers, who otherwiſe would not have been ſo. And I fear, that too great an opportunity has been afforded to atheiſtical wits, by unintelligible fancies, which many have made bold to add to what the ſcripture has revealed, concerning the eternity and infiniteneſs of God. For whilſt men indiſcreetly and unſkilfully twiſt together, as integral parts of the ſame doctrine, a revealed truth with their own metaphyſical ſpeculations about it, though theſe be too often ſuch as cannot be proved, or perhaps ſo much as underſtood; they tempt ſuch examining readers, as are rational enough to diſcern the groundleſſneſs of one part of the doctrine, to reject the whole for its ſake. But I fear I have digreſſed, for my intention was only to intimate, that it is not oftentimes ſo much what the ſcripture ſays, as what ſome men perſuade others it ſays, that makes it ſeem obſcure: and that as to ſome other paſſages, that are ſo indeed, ſince it is the abſtruſeneſs of what is taught in them that makes them almoſt inevitably ſo, it is little leſs ſaucy, upon ſuch a ſcore, to find fault with the ſtyle of the ſcripture, than to do ſo with the author for making us but men.

THUS much being ſaid, by way of anſwer, to the firſt ſort of objectors of darkneſs againſt the ſcripture, it is eaſy to foreſee, that the ſecond ſort of them may endeavour to pervert what has been delivered to apologize for their neglect of the ſcripture, by alledging, that albeit what has been repreſented may ſerve to ſhew, that the obſcurity of the ſcripture is juſtifiable; yet the very proving it needful or fit, that it ſhould be obſcure, is a plain confeſſion that it is ſo. Wherefore it is requiſite, that I now ſay ſomething to this ſort of objectors alſo, who are ſo unfavourable to the ſcripture and themſelves, as that, becauſe they cannot underſtand all of it, they will not endeavour to learn any thing from it. I have already acknowledged it, and ſhall not now deny, that (as heaven it ſelf is not all ſtars) there may be parts of ſcripture, whoſe clear expoſitions ſhall ennoble and bleſs the remoteſt of ſucceeding ages, that perhaps ſome myſteries are ſo obſcure, that they are reſerved to the illumination and blazes of the laſt and univerſal fire.

BUT here it would be conſidered in the firſt place, that thoſe texts, that are ſo difficult to be underſtood, are not neceſſary to be ſo. In points fundamental and indiſpenſably neceſſary, the darkneſs of ſcripture is no leſs partial, than that of *Egypt*, which benighted only the enemies, but involved not the people of God: in ſuch articles as theſe, *If the goſpel be hid, it is hid to them that are loſt, in whom the God of this world hath blinded the minds.* At leaſt in relation to ſuch truths as theſe, we may juſtly apply that of *Moſes*, where he tells *Iſrael*, *This commandment, which I command thee this day, is not hidden from thee, neither is it far off. But the word is very near unto thee, in thy mouth, and in thy heart, that thou mayeſt do it.* And ſurely the Bible's being appropriate (as it ſelf tells us) *to enlighten the eyes, and to make wiſe the ſimple*; and it being written for the uſe of the whole people of God, whereof the greater number are no clerks, things are there expreſſed with an evidence proportionable to the degree of aſſent that they exact, and are as far forth intelligible to pious and induſtrious readers, as they are neceſſary to be underſtood by them; and we may not unfitly ſay of the underſtanding of thoſe cloudy paſſages of ſcripture, what I remember a father ſaid of the ſacrament, *That not the wanting of it, but the ſlighting it ſhall condemn men.* It is our duty to ſtudy them, but it is not (always) to underſtand them.

2 Cor. iii. 4.

Deut. xxx. 11, 12, 13, 14.

Pſal. xix. 7, 8.

Non privatio, ſed contemptus damnat.

AND as the knowledge of thoſe texts that are obſcure, is not neceſſary, ſo thoſe others, whoſe ſenſe is neceſſary to be underſtood, are eaſy enough to be ſo. And thoſe are as much more numerous than the others, as more clear. Yes, there are ſhining paſſages enough in ſcripture, to light us the way to heaven, though ſome unobvious ſtars of that bright ſphere cannot be diſcerned without the help of a teleſcope. Since God, then, has been pleaſed to provide ſufficiently for our inſtruction, what reaſon have we to repine, if he have in a book, not deſigned for us alone, provided alſo for thoſe, that are fitted for higher attainments? eſpecially ſince, if we be not wanting to ourſelves, thoſe paſſages, that are ſo obſcure as to teach us nothing elſe, may at leaſt teach us humility.

NOR does it miſbecome God's goodneſs, any more than his wiſdom, to have ſo tempered the canonical books, as therein to leave all ſorts of readers an exerciſe for their induſtry, and give even the greateſt doctors continual inducements to implore his inſtructions, and depend on him for his irradiations, by leaving, amongſt many paſſages, that ſtoop unto our weakneſs, ſome that may make us ſenſible of it. It ſhould, methinks, be looked upon as the prerogative, not the diſparagement, of the ſcriptures, that the revelation of his truth, vouchſafed us by God in them, is like a river, wherein a lamb may quench his thirſt, and which an elephant cannot exhauſt. I ſhould think him but an ill-natured child, who ſhould be angry to ſee ſtrong meat provided for his elder brothers, becauſe he himſelf can yet digeſt nothing but milk: and as the ſame child, being grown up to riper years, would be then troubled, that, according to his firſt envious wiſh, there were no ſtronger aliment provided in the family than milk; ſo when, by the attentive and repeated peruſal of the ſcripture, a child in knowledge ſhall attain to ſome higher meaſure of ſkill in the ſcriptures, he will then be well pleaſed to have his underſtanding exerciſed by thoſe moſt myſterious texts, of which he formerly complained that they ſurpaſſed it. However, ſince there are ſo many plain paſſages of ſcripture, that clearly hold forth, not only all that is neceſſary for us to know, but, I fear, much more than we are careful to learn and practiſe, the zealous Chriſtian would no more decline feeding on this heavenly food, though all the hard places ſhould ſtill remain ſuch to him, than the Jews would forbear to eat the paſchal lamb, *though not a bone of it were broken.* And, in earneſt, would not he merit unrelieved beggary, that ſhould refuſe the profit of a rich mine, becauſe all thoſe of the world are not yet diſcovered, nor thoſe of the *Indies* exhauſted?

Exod. xiii. 46.

MOREOVER, the pretended obſcureneſs of the Bible is a miſtaken diſcouragement from reading it: for the frequency of reading it ſtill leſſens that obſcurity; which, like a miſt, ſeems thicker at a diſtance, than when one enters it, and attempts a paſſage through it; which, in our caſe, many pious ſtudents have done ſo proſperouſly, as to find, by welcome experience, that what, at a diſtance, deterred them, was not intended to fruſtrate induſtry, but puniſh lazineſs.

BESIDES that, the ſcripture being avowedly the beſt expoſitor of itſelf, our ignorance of thoſe places, whoſe ſenſe we ſeek for, makes us often occaſionally much knowinger, and more perfect in the meaning of all the reſt; and makes us too ſo much more ready in the uſes of them, that I cannot but apply to this ſubject the fable of that dying huſbandman, who, by telling his ſons of a hidden maſs of wealth he had buried in a nameleſs place of his vineyard, occaſioned their ſo ſedulous delving all the ground, and turning up the earth about the roots of the vines, that they found indeed a treaſure, though not in gold, in wine: for thus out of hope, by the light of underſtood ſcriptures, to penetrate the ſenſe of the obſcurer ones, we occaſionally ſo improve our knowledge and readineſs in the clearer paſſages, that our by-acquiſts do richly recompence our fruſtrated (or rather unſucceeding) pains; ſince our particular diſappointments hinder not the promotion of our general deſign, which is a greater proficiency in ſpiritual knowledge, and therefore ought not to deter us from the duty of thoſe ſearches, in which not only to diſcover is happy, but even the unſucceeding attempts are gainful, whatever the event be; the pains being ſeldom fruitleſs, but reaching either their end or recompence. And this prompts me to repreſent to you further, that not only the ſcripture is inſtructive upon the ſame account with other theological writings, but that we may hope to improve our underſtandings by it upon this ſcore, that it is alſo the inſtituted means, as well of knowledge, as of grace, and appointed for our inſtruction by him, who, as ſin came into the world by man's liſtening to the words of the devil, is pleaſed to make reſtoring-grace operate chiefly by our liſtening to the word of God, whether heard or read. Wherefore thoſe, whom the intuition of this encouragement invites to be diligent peruſers of the ſcripture, do to their unfirm underſtandings, as the inhabitants of *Gennazareth* did to their ſick and Mark vi. weak countrymen, lay them in *Jeſus* his way, and conſequently in that of recovery. 56. It is of (at leaſt one of) the darkeſt books of the ſcripture, that it is ſaid, *Bleſſed is* Rev. i. 3. *he that readeth, and they that hear the words of this prophecy.* The eunuch in the *Acts* would (though upon the highway) needs read the Prophet *Iſaiah*, and though (as appears by his queſtion to *Philip*) as then he underſtood not what he read, yet did the Spirit take thence (perhaps a riſe, as well as) opportunity to reveal Chriſt unto him, and both ſatisfy him of the meaning of that prediction, and acquaint him with the freſh and happy accompliſhment of it. And ſurely this conſideration of the Bible being one of the conduit-pipes, through which God hath appointed to convey his truths, as well as graces, to his children, ſhould, methinks, both hugely animate to the ſearching of the ſcriptures, and equally refreſh us in it. For as no inſtrument is weak in an omnipotent hand, ſo ought no means to be looked upon as more promiſing, than that which is like to be proſpered by grace, as it is deviſed by omniſcience. We may confidently expect God's bleſſing upon his own inſtitutions, ſince we know, *that whatſoever we aſk according to the will of God, he will give it us*; and 1 John v. we can ſcarce aſk any thing more agreeable to the will of God, than the competent 14. underſtanding of that book, wherein his will is contained.

THE difficulty ought not to deter us from the duty of ſearching the ſcriptures, the difficulteſt commands of God being a warrant to a believer's confidence of being enabled acceptably (though not exactly) to obey them; which St. *Peter* ſeems to Matth. xi. have known well in the theory, though he failed in the practice, when to be enabled 28. to walk upon the ſea, he deſires only, that our Saviour would pleaſe to command him to come to him upon the water. The Bible is indeed, amongſt books, what the diamond is amongſt ſtones, the preciouſeſt, and the ſparklingeſt, the moſt apt to ſcatter light, and yet the ſolideſt, and the moſt proper to make impreſſions. But were it as unſuitable to its end, as it is the contrary, I ſhould remember, that our Saviour could ſucceſſively employ even clay and ſpittle to illuminate blind eyes: and John ix. 6. though I thought the Bible to be, on other accounts, no more than equal to other books of morality and devotion, God's deſignation would make me ſtudy it more hopefully, by minding me of that of the Syrian leper, when he would needs have *Albana* and *Parphar*, rivers of *Damaſcus*, likely to be as medicinal for his diſeaſe as 2 Kings v. *Jordan*; and vainly fancied, that God's appointment could not put a difference 12. betwixt things that knew no other.

I KNOW, that becauſe of the intermixture of ſome obſcurer texts of ſcripture with the clear ones, there are divers well-meaning, and even devout perſons, that leave the ſtudy of it for that of other books of religion, which, by leaving out all ſuch difficulter matters, ſeem to promiſe more of inſtruction. But, notwithſtanding this, I ſhall not much ſcruple to affirm, that as the moon, for all thoſe darker parts we call her ſpots, gives us a much greater light than the ſtars, that ſeem all luminous; ſo will the ſcripture, for all its obſcurer paſſages, afford the Chriſtian and Divine more light than the brighteſt human authors.

To diſpatch, ſince the ſcripture is both a naturally proper, and an inſtituted inſtrument, to convey revealed knowledge to the ſtudiers of it; and, in it, many clear paſſages may inſtruct ordinary capacities; and its darker ones may either recompenſe more inquiſitive wits, or humble them: I ſee not, why the obſcureneſs of a ſmall part of it ſhould deter any ſort of pious perſons from the peruſal of the whole. And, as the word of God is termed a *light*, ſo hath it this property of what it is called, that both the plaineſt ruſticks may, if they will not wilfully ſhut their eyes, by the benefit of its light, direct their ſteps, and the deepeſt philoſophers may be exerciſed, if not poſed and dazzled, with its abſtruſer myſteries. For, thus, in the ſcripture, the ignorant may learn all requiſite knowledge, and the moſt knowing may learn to diſcern their ignorance.

Pſal. cix. 105. Prov. vi. 23.

### *The ſecond* OBJECTION.

To proceed now to the ſecond objection againſt the ſtyle of ſcripture: the ſeemingly disjointed method of that book is by many much cavilled at; to which, were the ſuppoſal a truth, I might reply, that the book of grace doth but therein reſemble the book of nature; wherein the ſtars (however aſtronomers have been pleaſed to form their conſtellations) are not more nicely or methodically placed, than the paſſages of ſcripture, that where there's nothing but choice flowers, in what order ſoever you find them, they will make a good poſy: that it became not the majeſty of God to ſuffer himſelf to be fettered to human laws of method, which, deviſed only for your own narrow and low conceptions, would ſometimes be improper for, and injurious to his, who may well ſay (as he doth in the Prophet) that his thoughts are ſo far from being ours, that, *As the heavens are higher than the earth, ſo are his thoughts higher than our thoughts*; that, as a mixture of amber-greaſe and muſk is more redolent than the ſingle ingredients; and as, in compound medicines, (as mithridate and treacle) the mixture gives the electuary a higher virtue than the ſevered drugs poſſeſſed; ſo, oftentimes in morality and divinity, a complication of precept and example, of rhetorick and myſtery, may operate better than their diſtinction would. And ſure we ſhould judge that man a very captious creature, that ſhould take exception at a proffered ſum, only becauſe the half-crowns, ſhillings, and ſixpences, were not ſorted in diſtinct heaps, but huddled into one. This, I ſay, with much more, might be repreſented, were the ſcripture-ſeries as deſtitute of method, as pretended. But the truth is, that the method, though it be not pedantically nice, is proper and excellent: (if the goodneſs of a method be to be judged leſs by the order of the ſections, than its being in order to the author's end) and never ſwerved from, but upon ſufficient ground, or for ſome myſterious purpoſe; the laws of order in the ſcripture being rarely declined, but, as the laws of nature are in the world, for man's inſtruction. The hiſtorical diſlocations have their particular reaſons, and, for the moſt part, are accounted for by judicious expoſitors: and as for the frequent (and ſometimes long) digreſſions, excepted againſt in the epiſtles of St. *Paul*, were he a bare human writer, I ſhould poſſibly attribute his frequent excurſions to his fulneſs upon all ſubjects, not his want of ſkill to proſecute any one; and compare his pen to thoſe generous horſes, who, though never ſo well managed, will ever be jetting out on this or that ſide of the path, not out of undiſciplineneſs, but purely out of mettle. But, looking upon St. *Paul* under another notion, I ſhall rather chooſe to tell you, that

Iſa. lv. 8, 9.

that as rivers are ſaid to run to the ſea, though often-times the interpoſition of hard, or riſing grounds, or other obſtacles, force them to ſuch winding meanders, that they ſeem to retreat from the ocean they tend to; which nevertheleſs, with increaſed ſtreams, they afterwards bend again their intermitted courſe to, having watered and fertilized, by their paſſage, the grounds, through which they ſeemed to wander; ſo our Apoſtle, though he direct his courſe to his main ſcope, may not only without declining it, but in order to it, (for in ſome caſes the wiſdom of the proverb will inform us, that the longeſt way about, is the neareſt way home) ſeem for a while to abandon it, by fetching a compaſs to anſwer ſome obvious, or anticipate ſome tacit objection; and afterwards more proſperouſly reſume his former conſiderations, now ſtrengthened by the defeat of the interpoſing ſcruples, having by the by happily illuſtrated and enriched thoſe ſubjects, which his incidental excurſions led him occaſionally to handle. I muſt add, that in St. *Paul's*, as in the reſt of the inſpired writings, the meer want of heeding the Holy Ghoſt's way of writing makes the method appear to us at a very great diſadvantage. For in the hiſtorical parts of ſcripture, when the order of time is interrupted, thoſe προθύστερα προλήψεις and ἐπάνοδοι, and ſuch diſlocations, are uſed oftentimes only to comply with the connexion of the matter; and either diſpatch all that belongs to the ſame long narrative at once, or elſe to join paſſages allied in ſome other circumſtance, though ſevered in that of time; and ſometimes too things are inſerted, which do not readily ſeem pertinent to the ſeries of the diſcourſe, but are extremely ſo to ſome ſcope of the author, and afford much light and excellent hints to the reader. Sometimes the coherence, where it appears defective, may be very well made out, by rendering Hebrew verbs (and ſome Greek aoriſts) in a preterpluperfect ſenſe inſtead of a perfect; or by ſome ſuch other grammatical variation of the words, as all, that underſtand Hebrew well, know to be allowed by the propriety of that tongue, which ignores divers moods and tenſes, *&c.* of our weſtern languages. Sometimes that, which ſeems incoherent to a diſcourſe, ſerves really to prevent a foreſeen (though perhaps not always obvious) probability of the miſapplication of it; and ſo muſt not be judged impertinent to a doctrine, which it hinders from being either ſcrupled at, or abuſed. Sometimes the prophets in the midſt of the mention of particular mercies promiſed to, or judgments denounced againſt the people of God, ſally out into pathetical excurſions relating to the Meſſias, which ſeem extremely abrupt and incoherent with the reſt to them, that conſider not how ſeaſonable the mention of Chriſt may be, both in that of the mercies of God, of which he is the foundation and pinnacle, the ground and conſummation, (and the promiſe made of him, taught the faithful to reaſon thus with his Apoſtle, *He that ſpared not his own Son, but delivered him up for us all, how ſhall he not, with him, alſo freely give us all things?)* and with the threats of the judgments of God, in which he was his people's grand conſolation. Sometimes ὁ διδάσκαλος, the teacher, that biſhop of our ſouls, who was in the ſupreme degree of perfection, which St. *Paul* required of a biſhop, διδακτικὸς, both fit and forward to teach, takes a riſe from any invitation, either of a word, expreſſion, or theme, though belonging to his own firſt ſubject, to give further inſtructions, by digreſſing a little to that occaſional and intervening theme; which, however it related to his matter, ſuited very well with his merciful inclinations to inſtruct dim mortals. Sometimes, nay oftentimes, the inſpired diſcourſers ſeem to ſay things, not only incoherent, but contradictory; (as is very remarkable in divers of St. *Paul's* epiſtles, where he ſeems to praiſe and diſpraiſe the ſame perſons) whereas addreſſing themſelves to mixt aſſemblies, wherein (as *Noah* and *Ham* in the ark, and the tares and the wheat *in agro Dominico)* they were both good and bad men, hereticks, eſpecially Gnoſticks, and orthodox Chriſtians; they only

Rom. viii. 32.

John xiii. 13.

2 Pet. xi. 25.

1 Tim. iii. 2.

only ſo wiſely diſpenſed and tempered their diſcourſe, that both theſe ſorts of perſons might find ſomething, in what was in general terms delivered, to appropriate to themſelves in particular; which application was neceſſarily left to their own conſciences to make. Sometimes the order is in ſcripture much diſturbed, or injured, by the omiſſion or miſplacing of a parentheſis. For there not being any in the Hebrew copies, nor (as it is thought) in the original Greek ones, the publiſhers of the ſeveral editions of the Bible have placed parentheſes as they have judged moſt convenient; ſome including in them what others leave out of them; and ſome making long ones, where others make none at all; and perhaps none of them having been ſo happy, as to leave no room for alterations, that may deſerve the title of corrections and amendments. And ſometimes too, the ſeeming immethodicalneſs of the new teſtament (not to determine any thing of the antiquity, which is certainly great, and the authority of the accents, and partition of the old teſtament, becauſe amongſt very able criticks *adhuc ſub judice lis eſt)* is due to the inconvenient diſtinction of chapters and verſes now in uſe: which though it be a very great help to the memory, and be ſome other ways ſerviceable; yet being of no greater antiquity than its contriver *Stephanus*, and being (though now of general uſe) but of private authority, and by him drawn up in haſte; it will be perhaps no ſlander to that induſtrious promoter of heavenly learning, to ſay, he hath ſometimes ſevered matters, that ſhould have been left united, and united others, which more conveniently he might have ſevered; and that his lucky attempt ought not to lay any reſtraint upon the other learned men, from making uſe of the ſame liberty he took in altering the former partitions, (for of them I ſpeak, not of the punctuation) of the new teſtament, in altering his alterations, to the beſt advantage of the ſenſe or method. The analytical works of ſome (I wiſh I could ſay many) judicious expoſitors and divines upon the ſcripture may ſufficiently manifeſt its being generally reducible enough to a perſpicuous order; and that it conforms to the known laws of method, where its diviner one doth not tranſcend them. And it were not impoſſible for me to give divers inſtances to manifeſt, that as the north-ſtar, though it be leſs luminous than many others, yet, by reaſon of its poſition, doth better guide the pilot, than even the moon herſelf: ſo there are ſome texts in ſcripture, which, though leſs conſpicuous in themſelves, are, by reaſon of their relation to a context, more inſtructive than other more radiant paſſages; to which theſe would be much inferior, if they were not as well conſiderable for their being there, as ſuch.

### *The third* OBJECTION.

ALLIED to their objection, who find fault with the ſcripture for being immethodical, is theirs, who would fain perſuade us, that it is ſeldom coherent, and ſcarce any where diſcurſive. And I have obſerved, with trouble, that even ſome pious readers are eaſily tempted to look upon the Bible as barely a repoſitory of ſentences and clauſes, where divine truths lie huddled, and not ranged, and are too ready to apply to its texts the title *Nero* gave *Seneca*'s ſtyle, of *arena ſine calce*. Whereas an intelligent and attentive peruſer may clearly enough diſcern, both that the prophets and apoſtles do make frequent deductions and inferences, and that their arguments, though not caſt into mood and figure, are oftentimes as cogent as theirs, that uſe to make ſyllogiſms in *Barbara*. I frequently entertain my ſelf with both thoſe authors, and yet methinks, St. *Paul* reaſons as ſolidly, and as acutely, as *Ariſtotle*: Pſal. xciv. 7, 10. and certainly according to *David*'s logick, *(He that planted the ear, ſhall he not hear? He that framed the eye, ſhall he not ſee? He that teacheth man knowledge, ſhall not he know?)* the firſt and grand author of reaſon ſhould as well know how to manage and diſcloſe that faculty, as they that poſſeſs it but by participation, and gliſter ſo but with ſome few condeſcending beams, vouchſafed by that bright ſun, who is indeed the *father of lights, from which each good and perfect gift deſcends.* But on this occaſion, to point at a few particulars, I conſider,

Jam. i. 17.

1. THAT ſome ratiocinations of ſcriptures remain undiſcerned or miſunderſtood, becauſe of our unacquaintedneſs with the figurative, and (oftentimes) abrupt way of arguing, uſual among the Eaſtern people, who in their arguments uſed to leave much to the diſcretion and collection of thoſe they dealt with; and diſcourſed at a wide diſtance from the logical forms of our European ſchools, as to perſons verſed in their writings cannot but be notorious.

2. THAT the ſeeming incoherency of many ratiocinations proceeds purely from the miſrendering of the original particles, eſpecially of the Hebrew conjunction copulative Vau, or Vaf, (as it is diverſly pronounced by the Jews, of whom I ſhall here advertiſe you once for all, that they have confeſt to me, they differ in pronouncing Hebrew, not only from the Chriſtians, but exceedingly from one another) for there is hardly any of thoſe particles, that hath not, beſides the obvious various ſignifications, of which, if that were ſkilfully and freely in every text taken up, that would there afford the beſt ſenſe, the ſcripture would, I am confident, appear much more coherent and argumentative than tranſlations or expoſitors are wont to make it: and though I did but conſider, how many thouſand times the particle Vaf, is uſed in the ſcripture, and that it doth not only (though it do primarily) ſignify AND, but hath alſo (I ſpeak within compaſs) four or five and twenty other ſignifications (as *that*, *but*, *or*, *ſo*, *when*, *therefore*, *yet*, *then*, *becauſe*, *now*, *as*, *though*, &c.) and that the ſenſe only gives it this great diverſity of acceptions; I cannot but think, that if we always allowed our ſelves an equal freedom in rendering it, where the motive (which is the exigency or conveniency of the ſenſe) is the ſame; the dextrous uſe and rendering of that one particle would make no ſmall number of texts both better underſtood, and more eſteemed.

3. THAT ſometimes (eſpecially in *Solomon*'s and St. *Paul*'s writings) in many paſſages ſo penned as to contain (like *Seneca*'s) a tacit kind of dialogue, that is unſkilfully by readers, and even interpreters, taken for an argument or an aſſertion, which is indeed an objection: and that ſuch a miſtake muſt mightily diſcompoſe the contexture of a diſcourſe, even a raw logician need not to be told.

4. THAT the omiſſion or miſplacing of parentheſes (which the Hebrew text altogether wanting, interpreters have ſupplied and uſed at their own diſcretion) makes the ſcripture oftentimes appear leſs diſcurſive, as well as (what we elſewhere complain of) leſs methodical. And the like may be ſaid of the points of interrogation. For whether it be true or no what the criticks eſteem, that in the original Greek copies of the new teſtament there were no ſuch points, (as indeed I have found them wanting in the ancienteſt manuſcripts I have ſeen) it is certain, that in our modern copies, both Greek and tranſlated, the authors of ſeveral editions have variouſly placed them, as themſelves thought fit: and though, inſtead of the interrogative point, the Hebrews make uſe of their interrogative *He*; yet that the ſenſe of the words, and a certain ſuppoſed modulation, do oftentimes make an interrogation, where that *He* is wanting, an Hebrician can ſcarcely ignore, no more than a logician, that the interrogation is not always ſupplied to the beſt advantage of the ſcripture's logick.

5. THAT the apoſtles and other inſpired diſcourſers in the Bible divers times uſe arguments, not to convince oppoſers, but to confirm believers. For the perſons they reaſon with, being ſuch, oftentimes, as eſteem them teachers ſent from God, upon

whoſe ſcore all they teach exacts belief, they may without irrationality uſe arguments to confirm in their doctrine men already acquieſcing in the principles of it, and perſuaded of their integrity, ſufficiency, and authority, that it would be improper to urge againſt a refractory diſbeliever, that is convinced of none of theſe. And as maſters often uſe, in inſtructing their ſcholars, arguments, they would forbear to inſiſt on againſt a profeſſed antagoniſt; ſo the apoſtles dealing with thoſe, that thought them inſpired teachers, and fully inſtructed in the myſteries of ſcripture, and the deſigned diſpenſations of God, might juſtly draw inferences, not to be urged againſt an infidel, from a doctrine firſt delivered by themſelves, or from a text or paſſage, wherein thoſe, they reaſoned with, juſtly ſuppoſed they might know more of the mind and counſel of God than other men; and would teach nothing as ſuch, that was not ſo.

6. THAT arguments exquiſite, and (as artiſts term them) apodictical, had been oftentimes leſs proper in diſcourſes, which being addreſt to popular auditories, required rather popular arguments; which the inſpired diſcourſers employ, but as likely to be better underſtood, and more prevalent than thoſe, which are ſo logical, that they require logicians to reliſh them. Where teaching and perſuading is the deſign, not only the native cogency of a ratiocination is to be conſidered, but its proportion to their ſpirits it is addreſſed to, and its aptitude to work upon them. For as a ſpider will catch flies better than a hawk can; as a cat is more fit to deſtroy mice than a grey-hound, though this be ſtronger and ſwifter; and as the crowing of a cock will (according to famous naturaliſts) ſooner fright a lion than the bellowing of a bull, though the latter be much the more terrifying noiſe, and proceed from the more formidable animal: ſo oftentimes weaker and popular arguments ſucceed better with a reſembling auditory, than the irrefragable ſyllogiſms.

7. THAT divers ſcripture-arguments do not logically and cogently prove the thing they would perſuade, merely becauſe they were meant only for what logicians call *argumenta ad hominem*; (reaſonings deſigned not ſo properly to demonſtrate the opinion they contend for, irrelatively and abſtractedly conſidered, as to convince, of the truth of that opinion, the perſons they are addreſſed to) and conſequently the inſpired diſcourſers arguing *è conceſſis*, from principles conceded and confeſſed by thoſe they reaſon with, though the principles ſhould be unſolid, the ratiocination is not. Thus there are divers texts of the old teſtament applied to Chriſt in the new, which though they did not now inevitably conclude againſt the preſent Jews, were without any illogicalneſs employed againſt their anceſtors; becauſe then the relation of thoſe paſſages to the Meſſias was ſo acknowledged, that there needed but the pertinent applications made of them in the new teſtament; whereas the refractorineſs of the ſucceeding Jews hath taught them to deviſe ſo many ſophiſtical evaſions to elude the texts we ſpeak of, that they now diſpute, not only the application of them, but the explication too. St. *Jude* argues with the rodomonts of his time, out of the ſtory of the arch-angels and the devil's conteſt about the body of *Moſes*: and though perhaps that ſtory be (like the Jewiſh book, whence it ſeems not improbable it was taken) ſomewhat apocryphal; yet as long as they reverenced it, it was not irrational in him to urge them with it, and employ it to the redargution of their inſolence. And, although as there be nothing leſs ſolid and more fickle than the wind, yet the ſkilful pilot diligently obſerves it, and makes it drive on his ſhip more forcibly, than the powerfulleſt and beſt contrived engines in the world could; ſo though there be ſcarce any thing more groundleſs and unſtable than popular opinions and perſuaſions, yet a wiſe teacher neglects them not, and may ſometimes make ſuch uſe of them, as to draw thence arguments more operative than the accurateſt ſyllogiſms logick

could deviſe. And indeed the moſt convincing proofs of aſſertions being ever afforded by the mediums, wherein both parties agree, not only *Socrates* in *Plato*'s dialogues, but dextrous diſcourſers generally, have often elected the drawing of inferences from the opinions and conceſſions of thoſe they dealt with, as the moſt perſuaſive and ſucceſsful way of arguing; to all which I ſhall add,

8. THAT another thing, which very generally keeps men from diſcerning the reaſonings (and conſequently oftentimes the reaſonableneſs and true ſenſe) of ſcripture texts, is, the ſhineſs of divines to let the context and the ſpeaker's ſcope regulate their choice, amongſt all the various, though not equally obvious, ſignifications of ambiguous words and phraſes. It is not, that (as far as I have obſerved) men almoſt of all religions are not wont to make bold with (and perhaps for a need to ſtrain or wreſt) phraſes and words of ſcripture, when the giving them leſs uſual notions may fit them to ſerve their turns; but the miſchief is, that they decline the commoneſt acceptions, but to make the texts they quit them in, ſymphonize with their tenents, not with their neighbouring texts. It were methinks impartialler, if the frequenter ſenſe of an expreſſion were to be waved (as oftentimes it muſt) for one leſs current, to do this to make the ſcripture coherent, or diſcurſive: and then, for our opinions, rather to conform them to the ſenſe of the ſcripture, than wreſt the words of ſcripture to them. But perhaps this impartiality would ſilence too many of our clamorous controverſies (by ſhewing ſome to be groundleſs, and others undeterminable) to be likely to take place in the heated ſpirits of men; ſome of whom, I fear, whilſt their feuds and fierceneſs laſt, would be willinger to have the texts of ſcripture looſe ſtones, which they may more eaſily throw at their adverſaries, than built up into a ſtructure, wherein they muſt loſe that convenience, (it being difficult to pluck ſtones out of a building) though reaſon herſelf were the architect.

BUT to leave theſe eager diſputants to their animoſities, we ſhall again repeat, that the Bible loſes much by not being conſidered as a ſyſtem. For though many other books are comparable to cloth, in which by a ſmall pattern we may ſafely judge of the whole piece; yet the Bible is like a fair ſuit of arras, of which, though a ſhread may aſſure you of the fineneſs of the colours, and richneſs of the ſtuff, yet the hangings never appear to their true advantage, but when they are diſplayed to their full dimenſions, and ſeen together.

THESE things, *Theophilus*, among many others, may be repreſented on the behalf of the ſcripture, againſt thoſe, who will needs cenſure it as a collection, not to ſay a heap of immethodical and incoherent paſſages. But leſt you ſhould ſuſpect me of partiality, I ſhould ingenuouſly confeſs to you, that there are ſome things in the œconomy of ſcripture, that do ſomewhat diſtreſs my reaſon to find a ſatisfactory account of; and that there are very few things, wherein my curioſity is more concerned, and would more welcome a reſolution in. But when I remember, how many things I once thought incoherent, in which I now think I diſcern a cloſe (though myſtick) connection; when I reflect on the author and the ends of the ſcripture; and when I allow myſelf to imagine how exquiſite a ſymmetry (though as yet undiſcerned by me) omniſcience doth, and after-ages (probably) will diſcover in the ſcripture's method, in ſpite of thoſe ſeeming diſcompoſures that now puzzle me: when I think upon all this, I ſay, I think it juſt to check my forward thoughts, that would either preſume to know all the recluſe ends of omniſcience, or peremptorily judge of the fitneſs of means to ends unknown; and am reduced to think that oeconomy the wiſeſt, that is choſen by a wiſdom ſo boundleſs, that it can at once ſurvey all expedients, and ſo unbiaſſed, that it hath no intereſt to chuſe any, but for

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omniſcience comprizes and unites in one proſpect all times, and all events) to quell
ſome future foreſeen hereſy, which will not perhaps be born till we be dead; or
reſolve ſome yet unformed doubt, or confound ſome error, that hath not yet a name:
ſo that all the parts of the ſcripture are uſeful in ſome ages, and ſome in all. We
read in the goſpel, that at the firſt inſtitution of the euchariſt, it was expreſly ſaid to
Mat. xxvi. 27. the diſciples concerning the ſacramental wine, *Drink ye all of it*, whereas upon the
Mark xiv. 23. exhibition of the bread the particle *all* is omitted. This difference, it is like, the
primitive Chriſtians marvelled at, and diſcerning no reaſon for it, might be tempted
to think the paſſage uſeleſs or ſuperfluous: but we that live in an age, wherein the
cup is denied to much the greater part of the communicants, are invited not only
to abſolve the recording of this particularity, but to admire it. The ceremonial law,
with all its myſtick rites (which, like the manger of the ſhepherds, holds forth
Luke ii. wrapped in his ſwathing-cloaths the infant Jeſus) to many, that beſtow the reading
on it, ſeems ſcarce worth it: yet what uſe the Apoſtles made of it with the Jews;
and how neceſſary the knowledge of it is yet to us, in our controverſies with them,
he, that is any thing verſed in them, cannot ignore. And let me tell you, *Theophilus*,
that thoſe fundamental controverſies are both more neceſſary and more worthy a wiſe
man's ſtudy, than moſt of thoſe comparatively trifling ones, that at preſent ſo
miſerably (not to ſay ſo cauſeleſly) diſtract Chriſtendom. How many paſſages of the
Mat. i. prophets by lazy readers are thought to have no uſe, which, as the ſtar did the wiſe
men, lead the attentive conſiderers to Chriſt; and ſo loudly and harmoniouſly,
John i. 22. together with *Moſes*'s typick ſhades, utter thoſe words of the Baptiſt's, *Behold the
Lamb of God that taketh away the ſins of the world!* that I meet with numerous paſſages
in the new teſtament, to which I cannot but apply what St. *Matthew* notes upon his
Mat. xxvi. 56. narrative of our Saviour's apprehenſion: *All this was done, that the ſcriptures of the
prophets might be fulfilled*; or rather now all this was ſo done, that they were fulfilled;
for ſo oftentimes the context commands us to render the ἵνα in theſe citations, and
which recall to my mind the hiſtory of the transfiguration; for as there the Apoſtles
Mat. xvii. 3, 8. at firſt *ſaw* Moſes *and* Elias *talking with* Jeſus, but at the ſecond view (when the
cloud was with-drawn, and he had ſpoken to them) *ſaw none but* Jeſus *only*; ſo ſuch
paſſages, as I am ſpeaking of, in the law, the prophets, and the goſpel, at firſt
ſurvey appear very diſtinct things, but upon a ſecond inſpection, and the acceſs of
more light from an attentive collation of things, they do all, as it were, vaniſh into
Joh. i. 55. Chriſt; *of whom* (to uſe an Apoſtle's terms) Moſes *in the law and the prophets did
write:* and at whom thoſe types, and thoſe predictions pointed. Thoſe inſtances of
the old teſtament, of the confuſed or diſlocated mention of known pedigrees and
ſtories, were poſſibly uſeleſs, and even troubleſome to the ancient Jews; but ſerve us
extremely to ſilence the cavils of the modern ones, when they would invalidate the
new teſtament's authority; becauſe in St. *Stephen*'s narrative, and ſome of the Evangeliſt's genealogies, the Holy Ghoſt is pleaſed to employ, in the new teſtament, that
obſcure ſtrain he had oftner uſed in the old: (and ſure as inſultingly as the Jews uſe
to urge againſt us objections of that nature, I could readily retaliate, and repay them
in the ſame coin, were there no common enemy, that might be advantaged by our
quarrel, and employ either's arguments againſt both.) And as there are divers prophetical paſſages in the *Revelation*, which we know as little the uſe, as meaning of,
which yet doubtleſly our poſterity will not find barren, when once the accompliſhment ſhall have proved the expoſitor of thoſe predictions, whoſe event will (if it do
nothing elſe) atteſt the omniſcience of their inſpirer: ſo poſſibly, of many Moſaick
conſtitutions, whereof we Chriſtians find excellent uſes, moſt of the old Jews ſcarce
knew

knew any; at leaſt my converſation with our modern Rabbies ſhows me, that they, whilſt they obſtinately decline referring them to the Meſſias, can ſcarce make any more of the inſpired and myſterious laws of *Moſes*, (except thoſe that relate to the Zabian ſuperſtition, with which too moſt of their doctors are as unacquainted as ours) than the Egyptians, or Gymnoſophiſts, could of their ſacrifices and other ritual devotions.

IT is not, that I think all the books, that conſtitute the Bible, of equal neceſſity or equal uſefulneſs, becauſe they are of equal extraction; or that I eſteem the church would loſe as much in the prophecy of *Nahum*, as that of *Iſaiah*; or in the book of *Ruth*, as in the epiſtle to the *Romans*, or the goſpel of *John*, (as the fixed ſtars themſelves, though of the ſame heaven, are not all of the ſame magnitude and luſtre). But I eſteem all the conſtituent books of ſcripture neceſſary to the canon of it; as two eyes, two ears, and the reſt of the members are all neceſſary to the body; without divers of which it may be, but not be ſo perfect; and which are all of great, though not of equal uſefulneſs. And perhaps it might too without hyperbole be ſaid further, that as amongſt the ſtars, that ſhine in the firmament, though there be a diſparity of greatneſs compared one to another, yet they are all of them lucid and celeſtial bodies, and the leaſt of them far vaſter than any thing on earth; ſo of the two teſtaments, that compoſe the Bible, though there may be ſome diſparity in relation to themſelves, yet are they both heavenly and inſtructive volumes, and ineſtimably outvaluing any the earth affords, or human pens ever traced. And I muſt add, that as mineraliſts obſerve, that rich mines are wont to lie hid in thoſe grounds, whoſe ſurface bears no fruit-trees, (too much maligned by the arſenical and reſembling fumes) nor is well ſtored with uſeful plants or verdure; (as if God would endear thoſe ill-favoured lands by giving them great portions) ſo divers paſſages of holy writ, which appear barren and unpromiſing to our firſt ſurvey, and hold not obviouſly forth inſtructions or promiſes, being by a ſedulous artiſt ſearched into, (and the original word ἐρυνᾶν uſed in that text of *Search the Scriptures* does properly enough ſignify the ſearching for hid treaſure) afford, out of their penetrated bowels, rich and precious myſteries of divinity.

John v. 39.

*The fifth* OBJECTION.

THE next thing imputed to the ſcripture is, that it contains many things trivial or impertinent; and it is not impoſſible, but that ſome things may ſeem ſo, though they are not: of this ſort are disjointed ſpeeches, and abrupt tranſitions obſerved in many of our Saviour's diſcourſes; in which alſo we ſometimes read him to have anſwered, without being aſked the queſtion, (though that be otherwiſe ſalvable by a critick) and ſometimes to have anſwered to a quite other queſtion than that he was aſked. But this is not to be thought an abſurdity, but an excellency in the replies of Chriſt; who poſſeſſing the prerogative of diſcerning hearts, did preach after that rate; his oratory took a ſhorter way than ours can follow it in: he proſecuted his deſign by altering his diſcourſes; and wiſely meaſured the fitneſs of his heavenly ſermons, by their relation to his end, not his theme. For as he knew his hearers thoughts, he addreſt himſelf to them; and reaching them in their earlieſt formation, and, as it were, their firſt cradles before they had leiſure to paſs into the tongue, he not more convinced his auditory by anſwering their thoughts, than by thus manifeſting that he knew them. Of his ſo much undervalued parables, ſome, if not moſt, do (like thoſe oyſters that beſides the meat they afford us, contain pearls) not only include excellent moralities, but comprize important prophecies. The parable of the pregnant grain of muſtard-ſeed, that ſo ſuddenly grew to ſo large a plant, was a (now fulfilled) prediction of the admirably

Mat. xiii. 31, 32.

mirably ſwift progreſs of the goſpel; which from deſpicable beginnings, ſoon proſpered to a height, that rendered it almoſt as fit an object for wonder as for faith. That other Mat. xxi. 33. parable of the treacherous huſband-men clearly foretold Chriſt's death by the Jews malice, and their deſtruction for it. And I deſpair not to ſee unheeded prophecies diſcloſed in others of them, eſpecially being informed that there is a critick, (Monſieur *A. B.)* now at work upon a deſign of manifeſting many otherwiſe interpreted paſſages of the new teſtament to be prophecies; of whom no leſs than the famouſeſt of the modern Rabbies, *Menaſſe Ben-Iſrael*, (one time I made him a viſit at his own houſe in *Amſterdam)* gave me this character, that he took him for the ableſt perſon of the Chriſtians. Thoſe hiſtorical circumſtances quarrelled with, in Chriſt's parables, are like the feathers, that wing our arrows, which though they pierce not like the head, but ſeem ſlight things, and of a differing matter from the reſt, are yet requiſite to make the ſhaft to pierce; and do both convey it to, and penetrate the mark. But nothing is thought more impertinent in the ſcripture than the frequent repetitions. But the learned need not to be told, that many things ſeem to the ignorant, bare repetitions, which yet ever bring along with them ſome light, or ſome acceſſion; in that comparable to the ſtars, which, as like as they ſeem to vulgar gazers, are by the ſkilful aſtrologer taught to contain, under that colour and figure common to them all, very peculiar and diſtinct influences. I here alſo conſider, that in all languages there are ſome cuſtomary geminations and expreſſions, which, though to ſtrangers they appear ſuperfluous, if not abſurd, to the natives, and in the propriety of that ſpeech, are not only current, but oftentimes emphatical. I find withal, that there is ſcarce any of theſe ſeeming impertinencies, of which a learned and judicious expoſitor cannot aſſign a pertinent cauſe or reaſon; and I conſider too, that the books of ſcripture being indited, not all at once, but at very ſeveral and diſtant times, (according to the known ſaying, that *Nunquam ſatis docetur, quod nunquam ſatis diſcitur)* the repetition of the ſame ſins and errors required that of the ſame menaces and diſſuaſions; whoſe frequent enforcing, ſerving both to atteſt and convince the ſinner's obſtinacy, was not a bare repeating, but ſuch a redoubling as we are fain to uſe, to drive in a nail to the head; (and the words of the wiſe are, Ec. xii. 1. in the wiſe man's words, *As nails faſtened by the maſters of aſſemblies)* where though in all the renewed ſtrokes the buſy hammer gives, the act be ſtill the ſame, yet is no blow ſuperfluous; the number of them ſerving to compleat their operation. They that in peruſing books have the learning and ſkill to ſtrip them, of what oratory or ſtealth hath dreſſed and diſguiſed them in, will eaſily diſcern moſt of them to be but varied repetitions: which for my part I find differing from thoſe of ſcripture, but in that the latter do in the ſame words generally comprize new matters, whereas the former uſually preſent us ſtale matter in new words. And I conſider further, that our own ſad experience ſhowing us, that there is no ſingle text of ſcripture, that ſubtiler hereticks ſophiſtry cannot plauſibly enough elude; the Holy Ghoſt foreſeeing this from the beginning, hath mercifully and wiſely provided, that the fundamental truths of faith and manners ſhould be held forth in ſo many places, and in ſo much variety of expreſſions, that one or other of them muſt unavoidably intercept thoſe evaſions, and eſcape thoſe miſconſtructions, that ſophiſtry may put upon the reſt. Which providence alone hath preſerved many articles from the attempts of hereticks; making them both bluſh to queſtion, and deſpair to diſprove a truth atteſted by more than two or three witneſſes; and giving orthodox believers the ſatisfaction of having their anchor tied to a *threefold cord, which is not eaſily broken.* Moſt of the Bible's repetitions (or inculcation rather) teach us ſomething or other untaught before; and, as in Gen. xli. 25, 31. *Pharaoh's* viſion, though both the ears and the kine ſignified the ſame thing, yet *Joſeph's* interpretation ſhows, that neither was ſuperfluous; even thoſe few, that teach us nothing elſe, teach us at leaſt the importance (or ſome other attribute) of thoſe repeated points we were taught before. And I ſcruple not to compare the expreſſions of the ſcripture to a roſe, where though ſo many leaves nearly reſemble each other, there's not one of them, but contributes to the beauty and perfection of the flower.

### *The ſixth* OBJECTION.

Of contradictions preſumed betwixt paſſages of ſcripture.

I AM not unacquainted with the קרי *Keri*, and the כתיב *Cethîb*; nor the תקו׳ ספרים *Tikkûm Soph'rîm* in the old teſtament: nor yet with the *Variæ Lectiones* (eſpecially thoſe of the Eaſtern and Weſtern Jews, as they are called) taken notice of by modern criticks in the Hebrew text of the old, as well as in the Greek of the new teſtament. I am not neither altogether a ſtranger to the difficulties to be met with, in making good the citations we find made of divers texts of the former of thoſe ſacred inſtruments in the latter: in which they ſeem not unfrequently to differ much from what we find extant in the ancient teſtament, as to the words, and ſometimes too as to the ſenſe. Theſe things, I ſay, though by ſome much urged againſt the ſcripture, I am not ignorant of. But I think it not fit to conſider them in this place; not only, becauſe thoſe, that are much better qualified for ſuch a work than I, have done it already; but becauſe theſe objections relating rather to the truth or the authority, than to the ſtyle of the ſcripture, the nature of my preſent taſk does not oblige me to examine them. Eſpecially, ſince I have already ſaid ſomething of them, and may ſay more, in what I write on the behalf of the Chriſtian religion. And it is upon theſe grounds, *Theophilus*, that I alſo decline at preſent the conſideration of what is wont to be objected, as if there were a great many ſelf-contradictions to be met with in the ſcripture. Only I ſhall in the mean time invite you to take notice with me, that it is not oftentimes ſo much the various aſpects of the texts, as the divers prepoſſeſſions and intereſts of the expoſitors, that make books ſeem repleniſhed with interfering paſſages and contradictions. For if once the theme treated of do highly concern men's intereſts, let the book be as clear as it can, ſubtile and engaged perſons on both ſides, peruſing it with foreſtalled judgments of biaſſed paſſions, will be ſure to wreſt many paſſages to countenance their prejudices, and ſerve their ends, though they make the texts never ſo fiercely fall out with one another, to reconcile them to their partial gloſſes. Of this I might produce an eminent inſtance in *Ariſtotle*'s phyſical writings, alledged by ſo many diſſenting ſects of ſchool-men to countenance their jarring opinions; the injured *Stagyrite* (employed as ſecond by every one that quotes him) being by every ſect brought to fight with his antagoniſts, and by them all to give battle to himſelf. Thus do the diſſenting ſects of Mahometans quarrel as well about the ſenſe of their Alcoran, as we do about that of our Bible; and make the one as much a noſe of wax, as the Romiſh catholicks ſay we make the other. Which brings unto my mind, that not only the δυσνόητα τινα, the *ſome things hard to be underſtood* in St. *Paul*'s epiſtles, but alſo the λοίπαι γράφαι, the *other ſcriptures* are by St. *Peter* ſaid to be by the *unlearned and unſtable wreſted to their own deſtruction*. When a ſober author finds an impartial reader, who takes his words in their genuinely obvious acception, wherever the context doth not manifeſtly force another on them, (in which then the reader acquieſces) the writer is eaſily underſtood. But when nimble and foreſtalled wits peruſe an author, not to ſit down with his ſenſe, but to make him ſpeak theirs, (whether it be his own or no) and giving themſelves the pains and leiſure of conſidering all the poſſible acceptions of a word or phraſe, and the liberty of pitching upon that which beſt ſerves their preſent turn, allow themſelves to conclude, that becauſe it may ſignify ſo and ſo elſewhere, therefore it does ſo here: an author muſt be much warier than *Homer* and *Virgil*, whom *Eudocia* and *Alexander Roſs* have made evangeliſts, to keep

2 Pet. iii. 16.

his words from being tortured into a confeſſion of what was never in his thoughts. And a very pregnant inſtance of this truth we may obſerve in the law of our land, whoſe very end being to prevent or aboliſh ſtrifes; and which being written ſo punctually and expreſly, and in ſo peculiar and barbarous a ſtyle (clogged with ſupernumerary repetitions) that nothing but their been conducive to ſo good an end could make it ſupportable; is yet by mens concerned wits ſo miſconſtrued and perverted, that not only in private mens caſes, we ſee the judges ſo puzzled, that ſuits oftentimes out-laſt luſtres; but the prince's party and the ſubject's kill, and execute one another; and (as charity tempts me to preſume) think they may do ſo by the law, and do ſo for the law. In this belief, that we often impute to the ſcripture our own faults and deficiencies, the inſtances of thoſe anti-ſcripturiſts, I have converſed with, have very much confirmed me: though I have ſtill eſteemed, that the beſt as well as the ſhorteſt way, is not to wrangle with them about every nicety, where the defeat of their objections gives us no victory over incredulity, and by but evidencing the ſcripture's not being either falſe or abſurd, can ſerve but to juſtify our reverence to them, not to impart it; but by ſolidly aſſerting the divine orgination of the ſcripture, reduce men to aſcribe their ſcruples to the true cauſe; and perſuade us to the temper of the Apoſtles, who, when Chriſt had uttered a hard ſaying, which ſo unſettled many of his diſciples, that they deſerted him upon it; though (their groſs miſapprehenſions of numerous other much leſs obſcure paſſages will eaſily perſuade us) they reliſhed it not aright, yet would by no means forſake him for their maſter, becauſe, ſays their ſpokes-man,
John vi. 60, 66, 68, 69. *Peter, thou haſt the words of eternal life, and we believe, and are ſure, that thou art the Chriſt, the Son of the living God:* teaching us, with one grand and comprehenſive truth, to ſilence particular ſcruples. And one thing would not be unworthy our objectors conſidering; that the truth and authority of the ſcriptures, and conſequently their not being contradictory to themſelves, hath (as we may elſewhere have occaſion to manifeſt more at large) been immemorially believed by the learnedeſt men in the world; many of whom may be very reaſonably ſuppoſed to have examined opinions without any other concern in their inquiries than that of not being deceived; or any other end than that of finding out the truth; and moſt of whom, though by their ſedulouſneſs and their erudition they diſcovered difficulties in the Bible, that our quæriſts could never have dreamed of; yet did they all conclude the belief of the ſcriptures grounded on as much reaſon, as is conſiſtent with a due latitude for the exerciſe of faith: which poſſibly needs ſome dimneſs or reluctancy in the underſtanding, to be an acceptable virtue of the will; (faith and the twilight ſeeming to agree in this property, that a mixture of darkneſs is requiſite to both; with too refulgent a light, the one vaniſhing into knowledge, as the other into day). And now faith thus caſually preſents her ſelf in my way, it will, perhaps, not be impertinent to obſerve, that Chriſt often deals with new believers, as he is recorded to have done with *Nathaniel*; for as when that guileleſs *Iſraelite* had acknowledged him the Meſſias, upon the bare evidence of his having been diſcerned by him under the fig-tree, our
John i. 50. bleſſed Saviour tells him, *Becauſe I ſaid unto thee, I ſaw thee under the fig-tree, believeſt thou? Thou ſhalt ſee greater things than theſe*; (which in the next verſe he proceeds to mention) ſo when men once have embraced the perſuaſion of the ſcripture's being divinely inſpired, that faith is a thing ſo acceptable to God, that he often diſcovers to them, to confirm them in their belief, arguments much clearer than thoſe that induced them to it; and convinces them of the reaſonableneſs of having ſubmitted their reaſon to him that gave it them. And (as if there were myſteries, in which faith doth more proſperouſly make way for underſtanding, than that is ſet awork

to introduce faith) it happens to them, as it did to the two blind men mentioned in the goſpel, in whom our Saviour firſt required faith, and (having found that, he) then opened their eyes. Matth. ix. 27, &c.

### *The ſeventh* OBJECTION.

FROM the (not long ſince mentioned) frequent repetitions to be met with in the ſcripture, and from the unuſual method, wherein the author of it has thought fit, that the divine truths and precepts ſhould be extant there, divers have been pleaſed to take occaſion to criminate the Bible, as if, its bulk conſidered, it were but a barren book; wherein inſtructions are but ſparingly ſcattered, in compariſon of what is to be met with in divers other writings, where repetitions are avoided, and more of uſeful matter is delivered in fewer words. And hence it is (ſay theſe objectors) that many perſons unqueſtionably religious chuſe rather to ſtudy other books of devotion and morality, as containing more full and inſtructive precepts of good life.

I MIGHT anſwer this allegation by repreſenting, that the ſeveral particulars, whereon the accuſation is grounded, having been already examined by me, I need not ſay any thing diſtinctly to this accumulative charge. But becauſe I would not only defend my veneration for the ſcripture, but perſuade it, I ſhall on this occaſion offer two or three things to conſideration.

ALTHOUGH then the ſcripture were leſs repleniſhed with excellent doctrines, and were but, as well as the beſt of other books, like mines, in the richeſt of which the golden ore is mingled with ſtore of precious materials, (and needs a laborious ſeparation from them) yet ſure it would, like thoſe mines, deſerve to be carefully digged in: and it will become the grateful Chriſtian's zeal to imitate him in the parable, who having found *a treaſure hid in a field*, ſtuck at no price within his power, to purchaſe the whole field for the treaſure's ſake. Mat. xiii. 44.

BUT, God be praiſed, this is not the caſe; for it is only our ignorance, our lazineſs, or our indevotion, that keeps us from diſcovering, that the ſcripture is ſo far from being, as the objectors would have it, a wilderneſs or a barren ſoil, that it may be much more fitly compared to that bleſſed land of promiſe, which is ſo often ſaid in ſcripture to be flowing with milk and honey, things uſeful and delightful; if not to paradiſe itſelf, of which, it is ſaid, that there *the Lord God made to grow every tree, that is pleaſant to the ſight, and good for food; the tree of life alſo in the midſt of the garden.* Gen. ii. 9. And indeed, as the author of it was omniſcient, ſo experience has taught, that he has ſo much expreſſed himſelf to be ſo in the ſcripture, that the more knowing its pious ſtudiers have been, the greater ſtore of excellent truths they have met with in it; the ſcripture being indeed like heaven, where the better our eyes and teleſcopes are, the more lights we diſcover. And that this may not appear to be ſaid *gratis*, let us conſider, that a book may be inſtructive as well by teaching its readers ſpeculative truths as practical ones, and that Chriſtians ought as well to know what God would have us think of him and his works, as what he would have them do. Now as it is paſt queſtion, that there are no ſpeculative truths, of ſo noble and elevated a nature, as thoſe that have God himſelf for their object; ſo there is no book, from whence there is ſo much to be learned, as there is from the Bible, of the nature, and even the thoughts of God, and of thoſe deep myſteries, into which, as I formerly noted from St. *Peter*, the angels themſelves are greedy of prying. 1 Pet. i. 12. Nay, there is no other book whatſoever, that teaches us any thing at all, concerning divers of theſe ſublime ſubjects, that may be ſafely relied on, ſave in what it is beholden to the ſcripture for. So that we cannot without an extreme injury look upon that book as barren, which alone contains all thoſe revealed truths, which are of ſo noble and precious a nature, that we juſtly prize the compoſures of heathen philoſophers, and other authors, for being inriched with gueſſes at ſome few of them, though much embaraſſed by the alloy, whereto the truths, conjecturally delivered, are made liable from the imperfections of writers, always fallible, and, for the moſt part, in ſome degree or other, actually erroneous. But of this more perchance elſewhere. Wherefore I ſhall now add, that whereas thoſe we reaſon with, are pleaſed to prefer other books of morality and devotion before the ſcripture, in reference to good life; they would probably be of another mind, if they duely conſidered, that to engage men to live well and holily, there is much more requiſite, than barely to tell them, that they ought to do ſo, and how they ſhould do it. For ſince to lead a life truly virtuous requires in many caſes, that we deny and overcome our natural appetites and inclinations, and requires alſo conſtancy in a courſe, that is confeſſedly wont to be attended with many hardſhips and dangers; it is not ſufficient, to engage a man to a good life, to give him precepts of it; which do not ſo much (what is yet the main thing in this caſe) make men willing to conform to ſuch precepts, as ſuppoſe them ſo. And he, that can do no more, does far leſs than him, who, beſides the rules of good life, preſents men the higheſt, and the moſt prevalent motives to embrace piety and virtue, and the moſt powerful diſſuaſives from all that is wicked; by propoſing to us ſuch rewards and puniſhments, and ſatisfying us, that we ought, according as we behave ourſelves, to expect either the one or the other; as to convince us, that we cannot be either wiſe or happy, but by being good, nor avoid the greateſt of miſeries, but by avoiding vice. Now, as we ſhall ſee anon, that as to the precepts of good life, the Bible is not unfurniſhed with them; ſo as to that moſt operative part of the way of teaching good life, the propoſing of the moſt prevalent motives to good, and the moſt powerful diſſuaſives from evil; not only no other book does, but no book not inſpired, can perform, in that kind, any thing near ſo much as the ſcripture alone. Since we have not the ſame reaſon to believe any mere man, as we have to believe God, touching thoſe rewards and puniſhments, which he reſerves after death for thoſe, that conform to, or diſobey his laws; theſe being matters, which (whatever philoſophers and other learned men may have thought to the contrary) depend upon his free will, and conſequently are not to be explicitely known but by his revelation; which he has not, that appears, vouchſafed us in any other book than the ſcripture. And therefore it is not to be wondered at, that St. *Paul* ſhould aſcribe it to our Saviour 2 Tim. i. 10. Chriſt, *That he had brought life and immortality to light through the goſpel.* And whereas hope is that ſpur, without which men do ſcarce ever cheerfully undertake, and reſolutely go through things, much leſs difficult and dangerous than thoſe, which a virtuous courſe of life is wont to expoſe men to, St. *Peter* makes a Chriſtian's higheſt hope to depend upon a revealed truth, where he gives thanks to God for having, 1 Pet. i. 3. *according to his abundant mercy, begot us to a lively hope, by the reſurrection of Jeſus Chriſt from the dead.* And what influence ſuch a knowledge of God and Chriſt, as, if we have it at all, we muſt owe to the ſcripture, and ſuch hopes and promiſes, as none but God himſelf, or thoſe he ſends, can give a wary and intelligent perſon, may have upon good life, you may gueſs by that other paſſage of the ſame Apoſtle, where not 2 Pet. i. 3, 4. only he mentions God's having *according to his divine power* (or efficacy) *given unto us all things, that pertain unto life and godlineſs, through the knowledge of him, that hath called us to glory and virtue*, but alſo immediately after ſpeaks of our being made *partakers of the divine nature*, and *eſcaping the corruption, that is in the world through luſt*; by thoſe exceeding great and precious promiſes, that are given of God unto us. So that although the ſcripture did not expreſly give us ſuch moral documents as ethical writers do, and taught us good life, but by acquainting us with what God has revealed in thoſe writings concerning himſelf, and by convincingly propoſing to us thoſe higheſt inducements to embrace a good, and ſhun an evil life, which (though reaſon may perchance make ſome weak and confuſed gueſſes at them) revelation only can make examining men confidently depend upon: if, I ſay, the ſcripture did no more than thus engage us to reſolve upon a good life, leaving us to derive the particular precepts of virtue from the inward dictates of the law of nature, and the exerciſe of our own reaſon, (which two together may well teach us almoſt as much as ethical books are wont to teach, of really and conſiderably uſeful) the ſcripture ought yet to be eſteemed a moſt inſtructive book in reference to good life. As in effect we ſee, that the writings of no philoſopher or orator ever made any thing near ſo many perſons ſo virtuous, as the new teſtament, though but a pocket book, has been able to do; eſpecially in thoſe primitive ages of the church, when thoſe that received that book were leſs diverted from it, than ſince they have been by the reading of others. The moon may in clear weather lend a gardener light enough to dig, and manure his orchard, and perhaps to prune his trees; but none will ſay, that the moon does as much contribute to his labouring to produce fruit as the ſun; ſince this nobler planet not only affords him light to work by, and a comfortable warmth whilſt he is working, but animates him by the hopes he cheriſhes upon the ſun's account, that in due ſeaſon his diligence and toils ſhall be rewarded. The application is too obvious to need to be inſiſted on.

BUT though upon the fore-mentioned accounts alone, the ſcripture would deſerve to be looked upon as highly conducive to the practice of piety and virtue; yet it is far from being true, that it is deſtitute of ſuch moral documents, which it needs not, to deſerve to be looked upon as a book very inſtructive in reference to good life. For there being two ſorts of virtues requiſite to an embracer of the goſpel, which have been conveniently enough called, for diſtinction-ſake, the one Chriſtian, and the other moral or ethical; I ſuppoſe it will not be doubted, but that the rules of thoſe virtues, that are properly Chriſtian, muſt be ſought for in the ſcripture, that being acknowledged by proteſtants, to have ſuch a ſufficiency as to matters of meer revelation, (which reſtriction too many do inconſiderately enough leave out) that in matters of that nature, divines often do, and in many caſes may, argue negatively, as well as affirmatively from the ſcripture; which eaſes us of many things obtruded as duties, merely by its not, either expreſly, or by conſequence, impoſing them upon us. So that as to things of this nature, there is ſuch a fulneſs in that book, that oftentimes it ſays much by ſaying nothing, and not only its expreſſions but its ſilences are teaching, like a dial, in which the ſhadow as well as the light informs us. Nor muſt we think, that the Bible is deſtitute of the beſt ſort of ſuch precepts, exhortations, and diſſuaſives, as we prize in ethical books; becauſe they are not expreſſed and ranged in the Bible, as they are wont to be in ſyſtematical compoſures; for not only there is extant in the ſcripture, to them that know how to conſtellate thoſe lights, a very excellent body of moral precepts; but there are likewiſe ſcattered the forcibleſt motives to the ſeveral duties, and the moſt retracting diſſuaſives from the contrary vices. And truly, it hath long leſſened my eſteem of our heathen morals, that ethicks being but the doctrine of regulating our paſſions, and directing our faculties, in order to the attainment of felicity, they have been hitherto handled by thoſe, to whom the nature of the faculties and paſſions of the mind was but very little known: whereas to the author of the ſcripture morals, the frame and ſprings, and faculties of our ſouls, being intuitively and moſt perfectly known, the moſt proper and powerful ways of working on them, cannot be unknown to him: and then certainly, one unacquainted with the trade will be much leſs likely to mend a watch, that is out of order, than a watch-maker. And indeed, even in reference to that other ſort of virtues, which are wont in the more confined ſenſe of the word to be called moral, there are I know not how many excellent notions and directions, relating to them, diſperſed up and down in the ſcripture; though by reaſon of their not being drawn up by themſelves, and of their being mingled with other matters, they are not ſo readily taken notice of by ordinary readers. Whereas, thoſe ſtudious peruſers, that ſearch the ſcriptures with a due diligence and attention, are not only wont eaſily enough to deſcry the moral counſels and preſcriptions over-looked by the other readers; but take notice of many excellent documents, that are plainly enough intimated or hinted there to knowing and diligent peruſers, though not clearly and expreſly enough to be found of thoſe, that think them not worth ſeeing.

WHEREFORE, as to thoſe religious perſons mentioned in the laſt propoſed objection, I cannot but think, that by neglecting the ſcripture for ethical compoſures, or even books of devotion, they as well wrong themſelves as the ſcripture: and therefore I ſhall take leave to think the worſe, rather of the practice of the men, than of the book of God. Scarce any thing has given me a favourabler character of *Luther*, than his wiſh, that all his books of devotion were burnt, when he once perceived, that the people's fondneſs and over valuation of them produced a neglect of the ſtudy of the Bible; to which you ſhall find, *Theophilus*, that the beſt of that nature being compared, are but (not to draw to our preſent purpoſe that of *Seneca* to his mother; Seneca de Conſ. and Helviam, cap. 9. *Paribus intervallis omnia divina ad omnibus humanis diſtant)* like the ſtars compared to the ſun, whoſe emanations confer on them their luſtre, but whoſe preſence drowns it. For though I deny not books of devotion a due degree of praiſe and uſefulneſs, yet I refuſe them the ſuperlative degree of either; and ſince the writers of the beſt of that kind of compoſures, either ſteal their beſt things from, or acknowledge that they borrowed them of the Bible; I would not have Chriſtians neglect the fountain for the ſtreams, and unwiſely, as well as unthankfully, elect to read God's word, rather in any book than his own; in which, to encourage us to ſtudy the precepts of a virtuous and holy life, we have ſuch peculiar and encouraging invitations.—Saint *Paul* ſeems to make it the (end and the) reſult of the ſeveral uſefulneſſes he attributes to the 2 Tim. iii. 17. ſcripture, *That it can make the man of God perfect, thoroughly furniſhed unto all good works*; *and is able*, (as he ſpeaks a little higher) Ver. 15. σοφίσαι εἰς σωτηρίαν, *to make us wiſe unto ſalvation*. There are indeed many excellent inſtructions given to us in other books; but they giving us directions, only towards the attainment of the advantages, conveniences, and ornaments of life; the ignorance of them only makes us miſs thoſe particular ends, whereto they give addreſſes, or whereof they facilitate our purſuits; but the knowledge, whoſe acquiſt, or neglect, imports endleſs joys or torments, we need ſeek only from the ſcripture: a Chriſtian to underſtand the duty of his faith and life, needing to underſtand no other book than the Bible; though indeed to underſtand the Bible well, it is ordinarily requiſite, that a pretty number of other books be underſtood. Chriſtians then have reaſon to ſtudy moſt that book, which underſtood, all others are needleſs to ſalvation, and which ignored, they are inſufficient. Acts x. 11, 12, 13. If Saint *Peter*'s viſion had been a reality, he would ſcarce, hungry as he was, have ranged abroad to hunt in this deſart or that foreſt for game, when he had a veſſel let down to him from heaven, containing in it's ſelf all manner of four-footed beaſts, and other objects of appetite, attended with a commanding invitation from heaven, *Riſe*, Peter, *kill, and Eat*. So when God ſends us from heaven in one volume, a, at leaſt virtual, collection of all thoſe divine truths and holy precepts, others ſcatteringly and ſparingly glean out of human books; the Chriſtians cannot but prize a book ſo comprehenſive, which by making it ſafe for him to ignore others by ſo merited an *Antonomaſia*, wears the title of *the book*, (for ſo the Bible ſignifies in Greek, as the Hebrews call it *Mikra*, which by excellence ſignifies *what's to be read.)*

Mikra Lectio.

*read.)*———There are precepts enough of virtue, and motives enough to conform to them, held forth in the Bible, if the contents of that divine book were believed and conſidered as they ought to be. It is a miſtake to think, that a large ſyſtem of ethicks, diſſected according to the nice preſcriptions of logick, and methodically repleniſhed with definitions, diviſions, diſtinctions, and ſyllogiſms, is requiſite or ſufficient to make men virtuous. Too many of our moraliſts write, as if they thought virtue could be taught as eaſily, and, much in the ſame way, as grammar; and leaving our rational motives to virtue, and determents from vice, with other things, that have a genuine influence on the minds and manners of men, they fall to wrangle about the titles and precedencies of the parts of ethical philoſophy, and things extrinſecal enough to vice and virtue; they ſpend more time in aſſerting their method, than the prerogatives of virtue above vice; they ſeem more ſollicitous, how to order their chapters than their readers actions; and are more induſtrious to impreſs their doctrine on our memories than our affections, and teach us better to diſpute of our paſſions than with them. Whereas, as the condition of a monarch, who is poſſeſſed but of one kingdom or province, is preferable to that of a geographer, though he be able to diſcourſe theorically of the dimenſions, ſituation, and motion, or ſtability of the whole terreſtrial globe; to carve it into zones, climates and parallels, to enumerate the various names and etymologies of its various regions, and give an account of the extent, the confines, the figure, the diviſions, *&c.* of all the dominions and provinces of it: ſo the actual poſſeſſion of one virtue is preferable to the bare ſpeculative knowledge of them all. Their maſter *Ariſtotle* hath herein been more plain, and leſs pedantick; who (by favour of his interpreters) hath not been nice in the method of his ethicks. And indeed, but little theory is eſſentially requiſite to the being virtuous, provided it be duly underſtood, and cordially put in practice; reaſon and diſcretion ſufficing, analogically, to extend and apply it to the particular occurrences of life; (which otherwiſe being ſo near infinite, as to be indefinite, are not ſo eaſily ſpecifiable in rules:) as the view of the ſingle pole-ſtar directs the heedful pilot, in almoſt all the various courſes of navigation. And the ſyſtems of moraliſts may (in this particular) not unfitly be compared to heaven, where there are luminaries and ſtars obvious to all eyes, that diffuſe beams ſufficient to light us in moſt ways; and as I, that, with modern aſtronomers, by an excellent teleſcope, have beheld perhaps near a hundred ſtars in the *Pleiades*, where common eyes ſee but ſix; and have often diſcerned in the milky-way, and other pale parts of the firmament, numberleſs little ſtars generally unſeen, receive yet from heaven no more light uſeful to travel by, than other men enjoy: ſo there are certain grand principles and maxims in the ethicks, which both are generally conſpicuous, and generally afford men much light and much direction; but the numerous little notions, (admit them truths) ſuggeſted by ſcholarſhip to ethical writers, and by them to us, though the ſpeculation be not unpleaſant, afford us very little peculiar light to guide our actions by. When I remember thoſe ancient heroes, that have ennobled ſecular, and are ennobled by ſacred ſtory, and whoſe examples ſuggeſted the precepts of virtue, before there were any written ones to conform to; I am tempted to ſay, that virtue was ſcarce ever better practiſed, than whilſt men had not yet talked of the definition of it: (as many an alchymiſt begs with rare notions of the nature of gold, which fills the coffers of merchants, that never ſaw mine nor furnace.) The grand precepts of morality are fruitful ſeeds, which, induſtriouſly cultivated, will bring forth fruits ſtill affording other ſeeds. And as for the motives to pious, and diſſuaſions from ſinful practices, though out of the many voluminous books of morality, there may be divers collected, not extant in the Bible; yet may a dextrous reader find in that heavenly book many more invitations to virtue, and determents from vice, than moſt men are aware of; and ſome of them of an importance, that renders one of them as much more conſiderable than many ordinary ones, as one fair pearl out of a jeweller's ſhop out-values a ſcore of thoſe little pearls, that druggiſts ſell by the ounce, or doth comprize many inferior inducements, (which wiſe men judge not of by tale, but value) as a piece doth twenty ſhillings. And though human authors do often in their parenetical treatiſes allow themſelves to be laviſh in ornaments, to expatiate into amplifications, and to drain common-places; yet whilſt they want an intimate admiſſion, all theſe are too often unable to reform, I ſay not thoſe that read them, but even thoſe that write them: whereas the experience of the primitive and heroical ages of the church does glorioſly manifeſt, that the inducements and diſſuaſives held forth in the Bible, though deſtitute of thoſe embelliſhments and advantages, where they are conſcionably entertained, and ſeriouſly pondered, are ſufficient to raiſe virtue to a pitch philoſophy durſt ſcarcely aim at. Nor indeed is the number great of pertinent and rational incitements, or determents, relating to virtue; and in diſcourſes, that have them for theme, how far ſoever the bows may extend, yet generally the knot lies in a little compaſs: and the analyſer, that ſhall crack many of thoſe compoſures, having ſevered the ſhells, ſhall find their kernels to be much alike. What this writer compares to one thing, that writer likens to another; thoſe ungrateful perſons to God, that one reſembles to ſwine, who eat the acorns without ever looking up to the tree they fall from, another compares to cattle, that drink of the ſtreams, without conſidering what fountain they flow from; theſe but preſent us ſeveral dreſſes of virtue and vice, where though the novelty and variety of habit ſerve to engage attention in all, and want not influence (at leaſt) upon eaſy and flexible natures, yet in conſiderate and diſcerning perſons, they alter not much the notion, under which the qualities themſelves are entertained. Nor will ſuch be apt to quarrel with the author of the ſcripture; becauſe the motives and diſſuaſives extant there are many of them old and known, or frequently repeated; the efficacy of them being ſo too. Were it not ſtrange, a phyſician ſhould decline exhibiting of mithridate, becauſe it was a known medicine, and famous for its cures many ages ſince? Doth bread leſs nouriſh us, or is it leſs uſed, becauſe it was (as men ſuppoſe) contemporary to *Adam*, and the moſt common food of all nations in all ages? And (as to the repetition of the ſame allegation and inducements, as often as men's condition returned to need them) the paucity of ponderous conſiderations in the ethicks often neceſſitating either (diſguiſed perhaps, yet) repetitions of the ſame, or the ſubſtitution of thoſe, that muſt be much inferior to be new; ſuch perſons as little admire, that reiterated employment of the ſame truths, as they would to ſee a ſoldier uſe a ſword, though he, and legions many ages before him, have conſtantly made moſt uſe of that weapon; or a general encourage his engaging ſoldiers by repreſenting to them honour, duty, ſpoil, neceſſity, and thoſe other known topicks uſed by himſelf at the head of his army, as often as he had occaſion to lead it on to fight. To all this I am invited by this occaſion to ſubjoin, that upon the ſcore of God's being both an omniſcient ſpirit and the ſupreme law-giver to the whole creation, the ſame truths, counſels, exhortations, diſſuaſions, *&c.* oftentimes have, and always ought to have, another-gueſs efficacy and prevalence on a Chriſtian reader, when he finds them in the ſcripture, than if he ſhould meet with the ſame in the books of heathen moraliſts, though learned and eloquent. And certainly, thoſe, that with ſuch reverence read the writings of thoſe great wits of antiquity, that have made the greateſt diſcoveries of truth, becauſe they believe them to have been endowed with very illuminated intellectuals, ought to pay them, and a book publiſhed by an omniſcient enditer, a reverence ſomewhat proportionate to the diſparity of their authors, ſince men (as *Elihu* ſpeaks in *Job*) *are but of yeſterday, and know little or nothing.* A wary perſon reads the wiſeſt authors, with a reflection, that they may deceive him by being themſelves deceived; and undergoes a double labour, the one in inveſtigating the meaning, and the other in examining the truth of what they deliver: but in the Bible, we are eaſed of the latter of theſe troubles; for if we find the ſenſe of a text of ſcripture, we cannot miſs a truth, being never deceived by that book, but when we deceive our ſelves by preſuming we underſtand it, when indeed we do not. I am otherwiſe affected to find the vanity of the world proclaimed and depreciated by him, that enjoyed all the delights and glories of it, than when I meet with the ſame truth from ſome beggarly Cynick, that never was admitted to taſte thoſe luſcious and bewitching pleaſures, and needs no great philoſophy to deſpiſe a world, he judges of by the ſcant ſhare the narrowneſs of his condition allows him of the joys of it, and of which (conſequently) his criminations ſhould as little move, as a blindman's of a black-moor; whom though he may (perchance) truly ſtyle ugly, yet he were of a ſomewhat eaſy faith, that ſhould think her ſo, barely upon the teſtimony of ſo incompetent a witneſs. Thus when God himſelf is pleaſed to reveal, what is vice or virtue, ſublime or deſpicable, truth or falſhood, happineſs or miſery, I have another-guiſe acquieſcence in his deciſions, than in the ſame met with in an human author, who having neceſſarily frailties and paſſions, is both obnoxious to miſtake, and capable to deceive. And therefore it is no wonder, that the ſlighting of God's dictates ſhould receive an aggravation upon the ſcore of their being his: as, our Saviour gave the precedency of the Ninevites converted by *Jonah* to them, that repented not at his preaching, becauſe he was *a greater than Jonah.* And therefore, though I have formerly been no very negligent peruſer of books of morality; yet knowing, that they have a power but to perſuade, not to command, and that the penalties of ſin or death are not inſeparably annexed to the diſobedience of their preſcriptions, I confeſs, I often find my ſelf but faintly wrought on by them. For I muſt acknowledge, that frequently aſſuming the liberty of queſtioning the reaſonableneſs of what human writers (whether philoſophers or fathers) are pleaſed to impoſe upon us; I find thoſe ſpecious and boaſted allegations, the apothegms of the ſages, the placits of the philoſophers, the examples of eminent perſons, the pretty ſimilies, quaint allegories, and quick ſentences of fine wits; I find all theſe topicks, I ſay, ſuch two-edged weapons, that they are as well applicable to the ſervice of falſhood, as of truth, and may by ready wits be brought equally to countenance contrary aſſertions. And really, moſt moraliſts, except in thoſe few duties, that nature herſelf hath foretaught us, to a man, whoſe reſtleſs curioſity leads his enquiries to all times and nations, will appear little other than fencers with wit, (I mean thoſe that have any;) for each of theſe popular topicks is ſuch an unſolid or uncertain foundation, that one man can build little on it, that an equally able antagoniſt may not with as ſpecious probability overthrow; and I fear, moſt of us have but too often found our corruptions ſophiſters enough to elude any ſuch thing, that preſſed that as a duty, which they had no mind we ſhould perform. But when I find any thing enjoined in the ſcripture, my conſciouſneſs to its being impoſed by that *father of ſpirits*, (who has both right to enact laws, which muſt be therefore juſt, becauſe he enacts them, and power to puniſh the trangreſſion of them, with no leſs than eternal death;) I then leave roving, and ſee where to caſt anchor. I think it my part without diſputing them to obey his orders, and acquieſce more in that imperious ἄυτος ἔφη, *Thus ſaith the Lord*, than in a whole dialogue of *Plato*, or an epiſtle of *Seneca*. I therefore love to build my ethicks (as well as my creed) upon the rock, and eſteeming nothing but

Mat. xii. 42.

Heb. xii. 9.

the true, proper, and ſtrict ſenſe of the ſcripture, (and what is convincingly deducible from it) to be indiſpenſably obligatory, either as (in matters of mere revelation) to faith or practice; it is no wonder, if I ſtudy God's will moſt in that book, wherein alone I think it revealed; and, truly, finding in my ſelf no motive more juſtly prevalent to obedience, than his right to exact it that requires it, few men are more ready than I, in diſtinguiſhing what indeed God ſays from what man would make him ſay. And if I allow my ſelf ſuch liberty to diſcern the text from the gloſs, in the writings of our vulgar interpreters, (of moſt of whoſe comments, for reaſons proſecuted into another paper, I am no great idolater) and even of the fathers of the church; I hope I ſhall not need to tell *Theophilus*, that in all other moraliſts I like the freedom to like or diſapprove, as upon examination my impartialeſt reaſon reliſhes them, or that I frequently fear their harangues will hardly paſs for demonſtrations, with thoſe wary teſters, that like not to be cheated, ſo much as into virtue, but chuſe to act as rational or Chriſtians, as well in relation to the inducements, as to the nature of what they do.

AMONGST the thirteen articles of the Jewiſh creed, one acknowledges the very expreſſions of the law (or pentateuch) to have been inſpired by God. That ſaying of the Rabbins is not altogether ſo hyperbolical, as a perfunctory reader would imagine, that upon each title of the law whole mountains (of doctrine) hang. I ſhall not mention, as any proof of this, the ſtrange myſteries they fancy in the ſtrange accenting of the ten commandments in the original, ſince their ſoberer doctors have in free diſcourſe confeſſed to me, that it is as much a riddle to them as us. Nor ſhall I inſiſt upon the Jews reducing the whole law to 613 precepts, affirmative and negative, according to the number of the letters of the decalogue; thereby inſinuating that all the laws, that regulate man's duty, are virtually or reductively comprized there. Although this Rabbinical notion, (not to call it whimſey) be in ſuch requeſt among them; and ſo known to thoſe, that are any thing converſant in Jewiſh authors, that I have ſometimes ſuſpected, that the conceit entertained by ſo many Chriſtian divines, that all the precepts, that relate to any part of the whole duty of man, are but juſt conſequences deducible from the decalogue, had its riſe thence. But I ſhall not, as I ſaid, ground my opinion of the pregnant inſtructiveneſs of the ſcripture, upon ſuch queſtionable, not to ſay altogether proof-leſs, conceits. That which may better perſuade a conſidering man, is, that beſides thoſe more reſplendent and obvious truths, wherewith the ſcriptures do evidently abound, there are many inſtructions exhibited, many truths aſſerted, many errors confuted, and many myſteries hinted, in the very expreſſions of holy writ, to an inquiſitive and concerned peruſer, which a heedleſs vulgar reader is not wont to take notice of. God, who in the ſcripture is ſaid *to cover himſelf with light as with a garment*, juſtifies that expreſſion in the ſcripture, where (as the firſt words, that he is recorded to have ever ſpoken, were יהי אור Yehi-or, *Let there be light)* the very words and phraſes, that cloath the ſenſe, are not alone emphatical, but oftentimes myſterious. The Apoſtle aſſures us, *whatſoever things were written*, even in the old teſtament, *were written for our learning*; but yet, beſides thoſe many particular ſentences of the Bible, that are not deſtitute of inſtructions, there are ſome ſo pregnant with them, that we may eaſily find this difference betwixt them and human writings, that thoſe firſt mentioned contain more matter than words, and the other more words than matter. Nay, many of the very flowers of rhetorick growing there have (like the marygold, that in hot countries points at the ſun) a virtue of hinting the uſefulleſt and the ſublimeſt truths; the Bible being in this like the tree of life, (flouriſhing in the *New Jeruſalem)* which not only afforded ſeaſonable fruit, but of which the very *leaves were for the healing of the nations*. As for

Pſalm civ. 2.

Gen. i. 3.

Rom. xv. 4.

Rev. xxii. 2.

for thoſe, who have in this and the laſt age made bold to depreciate the old teſtament, by pretending, that to Chriſtians the new is ſufficient; I am at preſent apt to think, that the doctrine of the goſpel, together with the light of nature, (which it excludes not, but rather ſuppoſes) contains all thoſe duties, which are abſolutely neceſſary to be performed by all Chriſtians, in order to ſalvation. And that conſequently, many divines, both Catholicks and Reformed, do inconſiderately enough preſs many things enacted in the old teſtament, as laws properly ſo called, which are not now, upon the ſcore of their being there enacted, obligatory to us Chriſtians, nor perhaps ever were to any, but the Jews, and ſome kind of Jewiſh proſelytes. But I think withal, that though it be hard to ſhew, that any thing is a neceſſary duty to Chriſtians, in the ſenſe above declared, if it cannot be ſhewn to be ſo, either by the new teſtament, or the light of nature: yet not only there are many particulars relating to ſuch duties, of which the old teſtament may excellently aſſiſt us to give ourſelves a more diſtinct and explicite inſtruction, than is eaſy to be collected from the new; but of the myſteries of our religion, there are many things delivered more expreſly, or more fully, in ſome paſſages of the old teſtament, than in any of the goſpel, as I could eaſily evidence, if I thought it requiſite. So that the uſe of it is very great, as to the *credenda* in divinity, though not perhaps abſolutely neceſſary as to the *agenda*. But I conſider further, that both the matters and the expreſſions made uſe of in the old teſtament are ſo very frequently, and, almoſt upon all occaſions, related to in the new, (as if the wiſdom of God were like rivers and ſeas, that affect to flow in the ſame channels themſelves had made before) that there is ſcarce a page of the latter, to the better underſtanding of which the ſtudy of the former is not either abſolutely neceſſary, or at leaſt highly uſeful. Should God be pleaſed to inſtruct us, as he did *Jonas*, by the ſhadow of a weed, it were our duty to acquieſce: how much Jonah iv. 6.
more then, when he vouchſafes to ſpeak to us in almoſt as glorious a manner as he did to *Moſes*; in a ſcripture, that hath ſuch reſemblances to the ſanctuary, which contained the law of God, exhibited the mercy-ſeat, (the type of Chriſt) and wherein the two golden cherubims, like the two precious and harmonious teſtaments, looked towards one another, and both towards that mercy-ſeat, that typified the Meſſias? Exod. xxv. 16, 17, 18, 19, 20, 21, 22.
We ſhould therefore, not only with acquieſcence, but gratitude, look upon God's having appointed the ſcripture to be the light, in which his ſpirit regularly ſhines upon his church; ſince the luminary is as well refulgent, as the choice of it his, whoſe bleſſing can proſper any means of grace, as without his bleſſing no means of grace can proſper.

AND, *Theophilus*, ſince among thoſe, that are ſo far miſtaken, as to poſtpone the ſtudy of the Bible to that of ſome applauded books of morality and devotion, there are not wanting divers perſons, otherwiſe eminently religious; I hope you will eaſily excuſe me, if, for fear their example ſhould prove a temptation to you, and add to the diſcouragements you muſt expect from the darkneſs of ſome texts, and the oppoſition, that will be given you, eſpecially at firſt, by the grand enemy to the author and deſign of the ſcripture; I venture to ſuperadd to all that I have ſaid already, concerning theſe mens practice, that it is not only a commendable, but a much more improving cuſtom, than it is by many thought, to read daily and orderly ſome ſet portion or chapters of the Bible; and, not to deſiſt from that practice, though (as *Naaman* dipped himſelf ſix times in *Jordan*, without being cured) we ſhould not 2 Kings v. 14.
perceive a ſudden and ſenſible benefit accruing from it. For in diſeaſes (bodily or ſpiritual) though the mouth be out of taſte, and cannot reliſh what is taken in, yet wholeſome aliments muſt be eaten, and do effectively nouriſh and ſtrengthen, though they be then inſipid, (perhaps bitter) to the diſtempered palate. We muſt, with the Acts viii. 30, 31.

eunuch, read divers texts we underſtand not, when we read them; and though, at
firſt, we be not able to penetrate the ſenſes of ſome portions of God's word, we muſt
at leaſt make our faculties as hoſpitable to it as we can; and make our memories
admit, and embrace it, till our underſtandings be grown up to do the like: it
becoming the diſciples of our Saviour, herein to imitate his holy mother, of whom it
is written, that *they* (the bleſſed virgin and her huſband) *underſtood not the ſayings,*
Luke ii. 50, 51. *which he ſpake unto them,*————*but his mother kept all theſe ſayings in her heart*;
See ver. 18, 19. and to think it may very well be, that, as our Saviour ſaid to *Peter*, *What I do,*
*thou knoweſt not now, but thou ſhalt know hereafter:* ſo, by the welcome he diſpoſes
John xiii. 7. you to give his word into your memory, he ſays to you, *What I ſay, thou knoweſt*
Heb. xiii. 2. *not now*; *but thou ſhalt know hereafter:* and the apoſtle's motive to hoſpitality, *Be not*
*forgetful to entertain ſtrangers, for thereby ſome have entertained angels unawares,* will,
without being overſtretched, take in the texts of ſcripture we are unacquainted with.
Gen. xviii. and Gen. xix. For we may eaſily in them, entertain with *Abraham* and *Lot*, greater gueſts than we
are aware of; and who, when their true condition appears, may recompence our
entertainment of them, by ſhowering bleſſings on us, and reſcuing us from the
company and deſtiny of the wicked. And ſure, if the Pagans laid up, with awful
reverence, thoſe dark and ſquinting oracles, that came (at leaſt many of them) from
the prince of darkneſs, and father of lyes; we ſhould bluſh to refuſe attentive
Acts vii. 38. peruſals, and lodging in our memories, to thoſe λόγια ζῶντα, thoſe *lively oracles*, thoſe
Rom. iii. 2. λόγια τȣ̃ Θεȣ̃, *oracles of God*, who is the father of lights, and an eſſential truth that
James i. 17. cannot lye. And the moſt ænigmatical texts we meet with, which ſeem meant purpoſely
Tit. i. 2. to poſe us, we may make uſeful admonitors of our weakneſſes, and take for
welcome opportunities, to evince how great a reverence we pay God's word, upon
the ſingle ſcore of its being ſo. Nor let thoſe diſturbances, with which the devil
ſeldom fails to obſtruct or diſcourage our firſt progreſs in a ſtudy ſo ruinous to his
malicious ends upon us, deter us; for theſe are commonly but the throws and ſtrugglings
of Chriſt new-formed in us; or elſe like thoſe horrid fits and outcries, which
Mar. i. 26. preceded the ejection of that unclean ſpirit mentioned in the firſt of *Mark*; ſuch
parting ceremonies being not unuſual to the diſlodging devil; who when he finds
himſelf upon the point of being expelled, *hath great wrath*, *becauſe he knoweth he*
Rev. xii. 12. *hath but a ſhort time. And though the God of peace*, however he *will bruiſe Satan under*
Rom. xvi. 20. *your feet ſhortly*, ſhould for a while try us even with deſertion in the ſtudy of the
ſcripture; let us not, for all that, deſert ſo improving a ſtudy, but reſolutely perſevere
in the conſtant and faithful uſe of the means of grace: as the moon, when ſhe ſuffers
an eclipſe, forſakes not her orb or motion, but, by continuing her unretarded courſe,
regains the irradiations ſhe was deprived of. We find the word of God compared to
Mat. xiii. 19, 20, &c. ſeed, (that deathleſs ſeed, by which Saint *Peter* ſaith, we are *born again)* and that,
1 Pet. i. 2, 3. we know, may ſeem, for a long time, as well dead as buried in the ground, and yet
afterwards ſpring and grow up into a plentiful harveſt. Nor muſt our proficiency
any more diſpenſe with us from the being converſant with the ſcripture, than our
Pſal. cxix. 93. frailties: *I will never* (ſaith the Pſalmiſt) *forget thy precepts, for with them thou haſt*
*quickened me.* And indeed, the word of God is not to be uſed like active phyſick,
1 Pet. ii. 2. and elſewhere. taken once, that it may not be taken again; but 'tis compared to food, which indeed
it is, of the ſoul; in which ſenſe it may be literally enough ſaid, *That man liveth not*
Mat. iv. 4. *by bread alone, but by every word that proceedeth out of the mouth of God.* Now as our
having fed never ſo well and heartily on excellent and nutritive meats yeſterday, will
not keep us from needing to eat again to-day, or to-morrow, and ſo daily, as long
as we continue in theſe ruinous cottages of clay; ſo in ſpiritual refections with full,
without repeated meals, the ſoul will ſcarcely thrive. And as, generally, the more

healthy and luſty men are, the frequenter and ſtronger appetites they have; ſo the beſt Chriſtians, and (witneſs *David*) the greateſt proficients in ſcripture-knowledge, have the keeneſt ſtomachs to this food of ſouls; and the vigorouſeſt piety, by a deſuetude and neglect of it, is ſubject to faint and pine away. Nor have we juſt cauſe to repine at an engagement to aſſiduity in the ſcriptures; for there are not near ſo many things, that will require, as there are that will deſerve and recompence a ſerious ſtudy in a book, where both the ſtrict ſenſe and the circumſtances, and expreſſions that cloath it, are richly inſtructive: like that aromatical fruit, of which, not only the kernel is a nutmeg, but the very involving ſkin is mace. This inexhauſted fulneſs occaſioned that panegyrical precept of the Rabbies concerning the law; הפוךבה יהפיך כה ארי כולי בה *Turn it over, and again turn it over, for all is in it:* concurrently to which, the Jew, that tranſlates the Arabian apothegms into Hebrew, thus pronounces; *There proceedeth not a true ſentence out of the mouths of this world's wiſe men, that is not intimated in our law.*

Τροφὴ ψυχῆς ἡ γραφή. Athanaſ.

Pirk avoth. cap. 5.

THE uſefulneſs of divers texts is ſuch, that we ſhould not only have them in our poſſeſſion, but in a readineſs; and as *David*, diſtreſſed by his mortal enemies, took *Goliah*'s ſword from near the ephod, to wear it whitherſoever he went; ſo Chriſtians, proſecuted by ghoſtly enemies, ſhould be diligent, not only to have an armory well furniſhed with ſpiritual weapons, but to wear this *ſword of the ſpirit* always by their ſides, to ward and thruſt with, upon all occaſions; without needing to depend upon any ſuch thing as concordances, which often cannot be come by, and oftner, not ſoon enough to keep us from being foiled by the father, or the champion of lyes. But now, to engage us to grow ready ſcripturiſts, it is not only true, that as the texts of the Bible interchange light with one another, and every new degree of ſcripture-knowledge is not only an acquiſt of ſo much, but an inſtrument to acquire more; ſo is that book a theme ſo comprehenſive and ſo fertile, that the laſt hour of a Chriſtian's longeſt and induſtriouſeſt life will ſtill leave undiſcovered myſteries in it: this, I ſay, is not only true, but it is alſo true, that the doctrines of it are of that importance, and find that oppoſition in our depraved nature, that even thoſe truths, that require but few peruſals to be underſtood, require many to be duly impreſſed; our prepoſterouſly partial memories, being rarely like quick-ſilver, wherein nothing will ſink but (that pretiouſeſt of metals) gold; for that alone is heavier than the mercury. *The word of Chriſt* muſt not be as a paſſenger, or ſparingly entertained in our minds, but muſt dwell there, and that richly: and the word, which St. *James* pronounces *able to ſave our ſouls*, he deſcribes as a graff, which muſt not only be cloſely embraced by that, wherein it is to fructify, but muſt continue there, to bring the ſtock and graff to (if I may ſo ſpeak) concorporate. And indeed we are ſo indiſpoſed to admit, and ſo obnoxious to deface, religious impreſſions, that we need, during our whole life, be converſant with the precepts of leading it piouſly.—But it is ſcarce more faulty in, than incident to, the froward nature of man, to be ever quarrelling with God's method of proſecuting his intentions; and (as if he were wiſer than his Maker) to criminate his conduct in his diſpenſations. Even that excellent perſon, the gloriouſeſt of virgins, and of mothers, whom all ages muſt deſervedly call *Bleſſed*, incurred her divine ſon's reprehenſion, for an intimated offer to alter his purpoſed method in diſcloſing himſelf. But God is too juſt to himſelf, and too merciful to us, to degrade (as it were) his omniſcience ſo far, as to ſuffer himſelf to be ſwayed againſt the dictates of it, by ſuch purblind and perverſe tutors as we; his goodneſs concerns him too much in our inſtruction, to ſuffer him to let our fancies indite his word. To attain his own ends, he makes choice of his own means and inſtruments, without needing our purblind eyes in the election; and what with unfathomable wiſdom he hath been

Epheſ. vi. 17.

Luke i. 48. John ii. 3, 4.

pleaſed to contrive for man's inſtruction with a gracious, though often miſ-underſtood conſtancy, he perſiſts in. He knows, that many, who are diſpoſed to cavil at the preſent contrivance or ſtyle of ſcripture, would be apt to take exceptions at any other: for ſome thing or other it muſt neceſſarily be; and the unimaginable diverſity of humours, judgments and prepoſſeſſions is ſuch, that as theſe now ſay, why thus, and not ſo? others would, in caſe of alteration, be as ready to aſk, why ſo, and not Mat. xi. 16, 17, 18, 19. thus? It is queſtionable, whether the Iſraelites were greater murmurers at *Pharoah* in *Egypt*, or at *Moſes* in the deſart: and the children complained of by their companions in the market-place have had either poſterity or predeceſſors in all ages; which have been ſtill of the diſpoſition of thoſe Jews, who imputed the more than prophets rigidneſs of virtue to the great enemy of that lovely quality; and the greater than *Solomon*'s condeſcenſions to the vices he deſigned them to deſtroy. But the great phyſician of mankind is too compaſſionate and wiſe, to let his diſtracted patients preſcribe their own courſe of phyſick, or, to decline our fond and peeviſh cavils, ſhuffle or diſcompoſe thoſe myſterious and profound contrivances; whoſe wiſdom engages the attention, 1 Pet. i. 12. and exacts the wonders of thoſe heavenly unclogged ſpirits, that are ſcarce more advantaged over us by their native abilities, than by the means they have of improving them. And therefore, our Saviour refuſed to deſcend from the croſs, though they, Mat. xxvii. 42. whoſe malice ſerved to fix him there, (the chief prieſts and ſcribes themſelves) declared, that on thoſe terms they would believe on him. And though we are (but too) apt to fancy, that we ſhould be won to our duty, if it were taught or preſſed in ſuch or ſuch a way; yet we may be pleaſed to remember, that it was one in hell, that would needs have another means than the ſcripture, of having ſinners preached to; Luke xvi. 31. and one in heaven, that referring them to the ſcripture, declared, *That if men heard not* Moſes *and the prophets, neither would they be perſuaded, though one roſe from the dead, to preach to them.*

If I addreſt what I write, not to ſo intelligent a perſon as *Theophilus*, but to promiſcuous readers, I ſhould add, to what I have ſaid of the ſeveral exceptions againſt the ſcripture, a cordial advice to all, whoſe parts and leiſure give them not a juſt hope of being able ſolidly to vindicate it either to themſelves or others, to decline as much as they diſcreetly can, the liſtening to objectors or objections, of what ſort, or under what diſguiſe ſoever, againſt that heavenly book; eſpecially, if propoſed by plauſible and inſinuating wits. For it not being neceſſary, (nor indeed poſſible) for every private Chriſtian, to know the opinions and reaſons of all diſſenters about the ſcripture, (no more than for every traveller to be a geographer;) nor requiſite to the knowledge of the way to heaven, to know all thoſe, in which they that miſs it, wander; (as to learn the way from *Dover* to *London*, I need not learn thoſe that lead not thither:) it is not prudent to run a very probable hazard of diſquieting one's faith, and a not improbable one of ſubverting it, only to gratify a needleſs curioſity; an itch, which we are delighted to have ſcratched, but which is exaſperated by being ſo. And frequently, though your deſign ſeem innocent, (as only to hear without believing, and pleaſe your ſelf with ſomething of wit and novelty) yet thoſe converſations rarely enough prove harmleſs; and (as too frequent and ſad experience proclaims) generally either abate a degree of your faith, or qualify ſome ardor of your love, or leſſen your reverence for that matchleſs book, or put ſome ſtrange and diſquieting ſcruples into your thoughts, which it is much eaſier to confute than to ſilence. Wherefore, as in infectious times, when the plague reigns, phyſicians uſe more ſtrictly to forbid the ſmaller exceſſes and inordinancies of diet, and the uſe of meats of ill digeſtion, or apt to breed any diſtemper; becauſe every petty fever becomes, through the malignity of the air, apt to turn into the plague: ſo now, that anti-ſcripturiſm grows ſo rife, and ſpreads ſo faſt, I hope it will not appear unſeaſonable to adviſe thoſe, that tender the ſafety and ſerenity of their faith, to be more than ordinarily ſhy of being too venturous of any books, or company, that may derogate from their veneration of the ſcripture; becauſe by the predominant and contagious profaneneſs of the times, the leaſt injurious opinions harboured of it, are prone to degenerate into irreligion. But I fear, you will think I preach.

### *The eighth and laſt* OBJECTION.

AND now, *Theophilus*, I am arrived at that part of this diſcourſe, wherein it will be fit to examine the grand objection againſt the ſtyle of the ſcripture, which, though a philoſopher would not look upon it as the moſt conſiderable, is yet moſt urged by many of its witty adverſaries; eſpecially ſuch as are wont to exerciſe and gratify their fancy more than their reaſon: the objection itſelf is this: 'That the ſcripture is ſo unadorned with flowers of rhetorick, and ſo deſtitute of eloquence, that it is flat, and proves commonly inefficacious upon intelligent readers. Inſomuch that divers great wits and great perſons, eſpecially ſtateſmen, do either deſpiſe it, or neglect to ſtudy it.' And truly, the ſtory is famous of that cardinal, (who flouriſhed in the laſt age) that ſaid, that once indeed he had read the Bible, but if he were to do ſo again, it would loſe him all his Latinity. And amongſt thoſe great orators, (as they thought themſelves) who lived in the ſame age and country that he did, the complaint was ordinary, that the reading of the Bible untaught them to the purity of the Roman language, and corrupted their Ciceronian ſtyle. And I remember no obſcure prince, (though he ſhall here be nameleſs, becauſe for other qualities I honour him) in no obſcure company, diſputed with me one day an opinion about the ſtyle of the ſcripture, to which the cardinal's ſcorn was a compliment. I wiſh theſe ſaucy expreſſions were but outlandiſh, and could not croſs thoſe ſeas, that environ *England*; (which is not ſo happily ſevered from the world's vices, as from its continent) this profane judging ſo boldly that book, men ſhall be judged by, being, if not a native, yet at leaſt a free denizon of *England*. For not only it was one, that I am ſorry I can call our countryman, who is recorded to have ſolemnly preferred one of the odes of *Pindarus*, before all the pſalms of *David*; but I could eaſily add divers reſembling inſtances, that I have my ſelf been troubled to meet with, were it not that I ſomewhat doubt, whether this kind of profane ſayings be not as well fitter as worthier to be forgotten than remembered, and to be ſuppreſſed than divulged: for (not to mention, that the recording of ſuch enormities puts an ill compliment upon mankind) the ſatisfaction ſome men's curioſities receive by ſuch relations, will ſcarce account for the temptation it gives others to imitate what they find ſome have dared. For there are ſome ſins, whoſe grand determent is a kind of perſuaſion, that they are too horrid to have been committed; and ſome wiſe legiſlators thought it better againſt certain crimes, to uſe the ſilence of the laws, than their threats. I ſhall therefore, without any further mention of ſcandalous particularities, take it for granted, that there have been, and are but too many witty diſreſpecters of the ſcripture. But as for the accuſation it ſelf, which they are alledged to countenance, many defences might be here made againſt it, if divers conſiderations pertinent to that purpoſe, among others, did not belong to ſome of thoſe enſuing parts of my diſcourſe, wherein it is not the ſtyle of the ſcripture, but other themes, that are principally and directly treated of. Yet that you may be aſſiſted to refer hither ſuch parts of the following diſcourſe, as are applicable to the matter under conſideration, I ſhall here take notice to you, that my anſwers to the objection above propoſed may for the moſt part be reduced to theſe five heads of argument.

FIRST, That as to divers parts of the ſcripture, it was not requiſite, that they ſhould be adorned with rhetorical embelliſhments.

NEXT, That the Bible ſeems to have much leſs eloquence than indeed it has, to thoſe that read it only in tranſlations, eſpecially the vulgar Latin verſion.

THIRDLY, That by reaſon of the differing notions, ſeveral ſorts of men, eſpecially of diſtant nations and climates, have of eloquence; many paſſages, that are thought uneloquent by us, may appear excellently expreſſed to another part of mankind.

FOURTHLY, That there are in the ſcripture a multitude of thoſe texts, wherein the author thought fit to employ the ornaments of language, conſpicuouſly adorned with ſuch as agree even with our notions of eloquence.

AND laſtly, That it is very far from being conſonant to experience, that the ſtyle of the ſcripture does make it unoperative upon the generality of its readers, if they be not faultily indiſpoſed to receive impreſſions from it.

As to the firſt of theſe, having already above declared, that there are many parts of ſcripture, wherein it would have been improper to affect eloquence; I am willing to ſuppoſe, that you have not yet forgot what has been formerly ſaid; and therefore, I am unwilling to detain you on this firſt conſideration. Yet I cannot but on this occaſion take notice to you, that we allow all ſorts of people expreſſions proper and fitted to their ſeveral profeſſions and themes. How many of us can dwell on lawyers, phyſicians, and chymiſts books; though oftentimes written in terms as harſh and as uncourtly, as if thoſe rudeneſſes were their deſign? And yet we can neglect and ſcorn the ſcripture, becauſe in ſome paſſages we there find the myſteries, and other matters of religion, delivered in a proper and theological ſtyle. I remember *Machiavel*, in the dedication of his famous *Prince*, after he had (not cauſeleſly) acknowledged to *Lorenzo de Medici*, (to whom this book is addreſſed) that he had not ſtuffed it with lofty language, or big words, nor adorned it with any of thoſe inveigling outward ornaments, uſual to other authors in their writings; gives this account of the plainneſs of his ſtyle, [*Perche io ho voluto, o chè veruna coſa la honori* (la mia opera) *o che ſolamente la verità della materia, & la gravità del ſoggetto la faccia grata*] that *he thought fit, either that nothing at all ſhould recommend his work, or that only the truth of the diſcourſe and the dignity of the ſubject ſhould make it acceptable*, and exact its welcome. If a mere ſtateſman, writing to a prince, upon a mere civil theme, could reaſonably talk thus; with how much more reaſon may God expect a welcoming entertainment for the leaſt adorned parts of a book, of which the truth is a direct emanation from the eſſential and ſupreme Truth, and of which the contents concern no leſs than man's eternal happineſs or miſery? And if our nice Italian criticks themſelves cannot, by the plainneſs of *Machiavel*'s ſtyle, nor the forbidding of his writings by the inquiſition, be deterred from as aſſiduous as prohibited a ſtudy of his books; what excuſe will they one day have, that now make the unaffected ſtyle of ſcripture the ſole excuſe of their deſpiſing, (or at leaſt neglecting) that divine book?

The ſecond anſwer to the eighth objection.

SECONDLY, As to the diſadvantage the ſcripture receives by its not being read by thoſe I now reaſon with, in its originals; though I have ſaid ſomething to it already, yet I muſt now reſume it into conſideration, and repreſent, that it is no wonder they reverence not the Bible's ſtyle, as they ought, whilſt they judge of that of an Hebrew book by their vulgar tranſlation; which (though ſometimes cauſeleſly enough cenſured by divers proteſtant divines, that would find it no eaſy taſk to make a better, yet) certainly is in many places ſtrangely harſh and barbarous; and by a partial and unlucky affectation of literality, miſſeth the propriety both of the Hebrew ſpeech, and of the Latin. And to adhere to the original words commonly injures its eloquence, and oftentimes ſenſe; rendering excellent expreſſions in ſuch ungraceful ones, as would probably fright readers from it, if it could not very well ſpare fine language. So that to our preſent theme we may not ill apply that notable ſaying of *Mirandula*; *Hebræi bibunt fontes, Græci rivos, Latini paludes.* The old French rhiming tranſlation of *Virgil* makes not the Æneids much more eloquent than *Hopkins* and *Sternhold* have made the pſalms: which ſure being written by a perſon, who (ſetting aſide his inſpiration) was both a traveller, a courtier, and a poet, muſt at leaſt be allowed to contain poliſhed and faſhionable expreſſions in their own language, how coarſely ſoever they have been miſ-rendered in ours. What opinion the eaſtern world hath of the ſweet-ſinger of *Iſrael*, may appear, both by other hyperbolical fictions they believe of him, (whom, with *Moſes*, *Jeſus* and *Mahomet*, they reckon amongſt the four great prophets) and by what *Keſſæus* (the famed Mahometan writer of the lives of the fathers) relates concerning him; *That when* David *ſang the praiſes of God, the hills,* Keſſæus, *and birds, and beaſts therein accompanied him.* Which groſs literal interpretation of page 99. figurative expreſſions in the pſalms, and of his pathetical invitations to the inanimate See Pſal. cxiv. 4. creatures to join with him in celebrating their common Creator, he ſeems to have Pſal. xix. borrowed from the Alcoran it ſelf; where *Mahomet* brings God in ſaying, ‘ We reduced Surat. 3. the mountains to comply with him, who ſhould join with him in praiſes Vide H. ‘ morning and evening; the birds alſo flock to him; and theſe are obſequious to him.’ Hotting. 62. and 63. And though the new teſtament be not written in Hebrew, yet its writers being Hebrews have chiefly conformed themſelves to the ſtyle of the tranſlators of the old teſtament, (which whether or no it conſtitute what criticks of late ſo diſpute of under the name of *Lingua*, or *Dialectus Helleniſtica*, I pretend not to define) and that of the apocryphal authors and other Jews writing in the ſame language; who (except perhaps *Joſephus* and *Philo*) wrote rather, if I may ſo ſpeak, an Hebrew than an Attick Greek; or at leaſt, in a dialect, which (by reaſon of their frequent references to the ſeptuagint's verſion) abounds, if not with Hebraiſms, with expreſſions obvious in Hebrew writings, and unfrequent in Greek ones, and ſo reliſhes much of the Hebraick ſtyle: of which, as well in the new as the old teſtament, thoſe we reaſon with, being ſtrangers to that primitive tongue, muſt be incompetent judges; there being in the idiotiſms of all languages peculiar graces, which (like thoſe moſt ſubtil ſpirits, which exhale in pouring eſſences out of one veſſel into another) are loſt in moſt (eſpecially if literal) tranſlations; and the holy tongue being that, which God himſelf made choice of to dignify with his expreſſions, having divers whoſe penetrancy is as little transfuſable into any other as the ſun's dazling brightneſs, or the water of a diamond can be undetractingly painted; and having divers words and phraſes, whoſe pithineſs and copiouſneſs none in derived (or other) languages can match. Some of the Hebrew conjugations, as thoſe called *Hiphil* and *Hitpaël*, give ſignifications to verbs, which the want of anſwerable conjugations in weſtern languages makes us unable to fill or equal without paraphraſes, which are very rarely ſo comprehenſive as the original words. And (to hint this upon the by) the ignorance, or not conſidering of this one grammatical truth, hath kept men from fully underſtanding divers paſſages of the new teſtament, wherein the Greek tongue's want of thoſe conjugations hath made active, or intranſitive verbs, be uſed in a tranſitive or reciprocal ſignification. How impertinently men's ignorance of its originals may make them cenſure the ſcripture, I had once occaſion to take notice of, by finding a famous commentator accuſing St. *Paul* of impropriety of ſpeech, in the beginning of that, which is commonly thought to be his firſt epiſtle to the Theſſalonians, but by the learned *Grotius* (in his paradoxes *De Antichriſto*) not improbably eſteemed to be his ſecond: for whereas inſtead of the Greek words ἀφ' ὑμῶν ἐξήχηται ὁ λόγος τοῦ κυρίȣ, which ours have rightly Engliſhed, 2 Theſ. i; *from you ſounded out the word*; he found in his tranſlation, *a vobis diffamatus eſt ſermo*; 8.

not knowing *Paul* to have written in Greek, he would needs correct him, for having written *Diffamatus eſt* inſtead of *Divulgatus eſt*.

The third anſwer.

Beidavi, Ahmedibn, Edris, and others.

Surat. x. S. 11. and S. 17.

J. Scaliger Epiſt. 362. apud Theod. Hackſpan in libro cui titulus, Fides & Leges Mohamedis. page 2.

THIRDLY, we may yet further conſider, that as to many paſſages of ſcripture, accuſed of not appearing eloquent to *European* judges, it might be juſtly repreſented, that the eaſtern eloquence differs widely from the weſtern. In thoſe purer climates, where learning, that is here but a denizon, was a native, the moſt cheriſhed and admired compoſures of their wits, if judged by weſtern rules of oratory, will be judged deſtitute of it. Their dark and involved ſentences; their figurative and parabolical diſcourſes; their abrupt and maimed way of expreſſing themſelves, which often leaves much place to gueſſes at the ſenſe; and their neglect of connecting tranſitions, which often leaves us at a loſs for the method and coherency of what they write; are qualities, that our rhetoricians do not more generally diſlike, than their practice; yet being perhaps little leſs diſparity in our opinions than in our ways of writing; for their pens (as if it were a preſage of the different changes the Jews and Greeks have made in point of religion) move from the right hand towards the left; ours (therein imitated by thoſe of the Ethiopians) from the left towards the right; ſo that we think they write backwards, and they, that we do. Of this difference of the notions, that the eaſtern and weſtern colonies of the ſons of *Adam* have harboured concerning eloquence, I ſhall need to mention but one inſtance, that one is ſo remarkable; and that is the Alkoran. How much the Mahometan world boaſts the eloquence of that book, can ſcarce be unknown to thoſe, that have (though but a little) buſied their curioſity in that ſort of inquiries. The ableſt Arabian expoſitors, and other authors, tell us, that all the wit and art of men and dæmons would be unable to hinder that book from being matchleſs. *Mahomet* himſelf was ſo proud of it, that in ſome paſſages in it he defies its oppoſers to equal one ſurat or ſection of it, and ſeems to make its peerleſſneſs an argument of its not being barely of human authority. And the Saracens, depreſſed with their religion's being deſtitute of atteſting miracles, will not ſcruple to reply, that though there were no other * miracle to manifeſt the excellency of their religion above that taught by the prophets, yet the Alkoran it ſelf were ſufficient, as being a laſting miracle that tranſcends all other miracles. How charming its eloquence may be in its original, I confeſs my ſelf too unſkilful in the Arabick tongue, to be a competent judge; my other ſtudies and diſtractions having made me forget moſt of the little knowledge I had once acquired of that flouriſhing language. But though the Alkoran have ſtolen too much from the Bible, not to contain divers excellent things, (which is one inducement to me to cite it the oftener) yet certainly, not only the ancient Latin verſion of it, made by order of the abbot *Petrus Guniacenſis*, and publiſhed in the laſt age, by the procurement of *Bibliander*, (and of which this is the grand critick *Scaliger*'s exclamation, *Deum immortalem, quam inepta eſt vulgaris illa, quam habemus, interpretatio!*) would ſcarce by our European orators be thought ſo much as of kin to eloquent: but the recent tranſlations I have ſeen of it in French, and (as to divers of it, in) Latin, elaborated by great ſcholars, and accurate Arabicians, by making it very conformable to its eaſtern original, have not ſo rendered it, but that perſons, that judge of rhetorick by the rules of it current in theſe weſtern parts of the world, would, inſtead of extolling it for the ſuperlative, not allow it the poſitive degree of eloquence; would think the ſtyle as deſtitute of graces, as the theology of truth; and would poſſibly as much admire the Saracen admiration, as they do the book. And not only what I have ſeen of the eminent

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* ——— *Etſi nihil præter ſolum Alkoranum (adduxiſſet) ſatis hoc foret ad eximiam excellentiam ſupra reliqua, quæ prophetæ adduxerunt: nam ille miraculum eſt, quod in ſecula durat præ omnibus aliis miraculis.* H. Hotting. Hiſt. Orient. *pagina circiter* 300.

Eaſt-Indians, is ſtrangely incongruous to our notions of eloquence; but what I have peruſed of the famous *Literati* (as they call the learned men) of *China*, though written with great care by the authors, and (as it ſeems) tranſlated with no leſs by the knowing interpreters, would, to an ordinary European orator, appear rather ridiculous than eloquent. But to content ourſelves with the examples we formerly ſelected out of the leſs remote parts of the Eaſt; ſince *Mahomet*, whoſe eloquence (almoſt as proſperous as his ſword) was able to bring credit and proſelytes even to ſuch a religion as his; ſince *Moſes*, that ſo celebrated legiſlator, bred up in the refining court, and all the famed wiſdom of the Egyptians; ſince *Solomon*, who had ſuch incommunicable advantages to improve himſelf, and whoſe wiſdom (eſteemed capable to have governed more kingdoms than his had ſubjects) the weſtern world hath for ſo many ages admired, and the eaſtern only not idolized; and ſince the prophet *Daniel*, whoſe promiſing youth was not only cultivated by the inſtructions of the Chaldean ſages, but enjoyed the diviner tutorage of God's ſpirit, and whoſe matchleſs abilities preferred him, from a captive, to be the chief as well of the Chaldean wiſe men, as the Median princes: ſince theſe applauded writers, I ſay, whom the eaſtern nations ſo much and ſo juſtly admired, by many of our Latiniſts are not thought good writers, becauſe of our differing notions of eloquence; nay, if amongſt Europeans themſelves, *Cicero* hath found many cenſurers, and a book hath been publiſhed to prove, that *Tully* was not eloquent; may not we rationally enough ſuppoſe, that the Grecian and Roman ſtyle, amongſt the eaſtern writers, may not be much better reliſhed than theirs is amongſt us; and that conſequently, in thoſe parts of the ſcripture, whoſe eloquence is not obvious to us Europeans, the pretended want of eloquence may be but a differing and eaſtern kind of it? Specially, if we conſider, that the ancienteſt writers in proſe, now extant amongſt us, were ſcarce cotemporary to the lateſt writers of the old teſtament; and yet that eloquence, the dreſs of our thoughts, like the dreſs of our bodies, differs not only in ſeveral regions, but in ſeveral ages. And oftentimes in that, as in attire, what was lately faſhionable, is now ridiculous; and what now makes a man look like a courtier, may within theſe few luſtres make him look like an antick: though how purely it is the mode, that makes ſuch things appear handſome or deformed, may be readily collected from the viciſſitudes obſervable in modes; men by intervals relapſing into obſolete faſhions. That there are great changes in that mode of writing men commonly miſtake for eloquence, I ſhall produce no leſs illuſtrious a witneſs than *Seneca*, who in his hundred and fourteenth epiſtle, (to omit other paſſages in his works) not only proves it at large, but ſhows, that in ſome ages, even the faulty ways of expreſſion, conſpired in by the wits of thoſe times, have paſſed for eloquence. The ſcripture ſtyle then, though it were not eloquent now, may have excellently ſuited the genius of thoſe times its ſeveral books were written in; and have been very proper for thoſe people it was primarily deſigned to work upon. And if I would preſume to be paradoxical in a thing I ſo little pretend ſkill in, as eloquence, I might further repreſent on this occaſion, that rhetorick being but an organical or inſtrumental art, in order chiefly to perſuaſion, or delight, its rules ought to be eſtimated by their tendency, and commenſurateneſs to its rules; and conſequently, are to be conformed to by a wiſe-man, but ſo far forth as he judgeth them ſeaſonable and proper to pleaſe or to perſuade: which when he ſees, he can do better by declining them, than by practiſing them, (as orators, like hunters, muſt oftentimes leave the moſt beaten paths, if they will not loſe their game) he ſhould not ſcruple to prefer the end to the means; the ſcope of the artiſt, to what the ſchools are pleaſed to call the ſcope of the art; and to think it more eligible to ſpeak powerfully, than to ſpeak regularly. And we may hence conſider, that it may be ſomewhat inconſiderate to

A ſhort digreſſion concerning the art of rhetorick.

judge of all eloquence, by the rules of it, that *Cicero*'s admirers impoſe on us; and confound their ſyſtems of precepts with the art of rhetorick, as if they were equivalent, or of the ſame extent. For *Cicero* being reputed (and that deſervedly) an eloquent man, and very ſucceſsful in perſuading his thus and thus qualified hearers; divers, whoſe modeſty and deſpair kept them from aſpiring to more than imitation, obſerving, that *Tully* often made uſe of ſuch and ſuch a contrivance, and ſuch and ſuch figurative forms of ſpeaking, took the pains to reduce thoſe obſervations into rules, which being highly applauded by their ſucceſſors, and by them recruited with ſome reſembling rules drawn from the practice of a few other orators, were afterwards compiled into an art, which as I deny not to be a great help to the imitation of *Tully* and *Demoſthenes*, or thoſe others, from whoſe ſtructure and faſhions of ſpeech ſuch inſtitutions have been drawn, ſo I ſhall no more take it for a complete ſyſtem of rhetorick, than any inſtructions deducible from the journals of *Solomon*'s Taſhiſh fleets, and from the Grecian and Roman ſea-voyages, for the true and entire art of navigation. For if other perſons, either by an endowment or improvement of nature, can find others equally, or more happy and powerful, or moving, (though never ſo differing) ways of expreſſing themſelves, they ought as little to be confined by the preſcriptions acquieſced in before them, as *Columbus* thought himſelf obliged to be by the rules or practice of ancient navigators; whoſe methods and voyages had he not boldly ventured to vary from, and paſs beyond, how vaſt and rich a portion of the world had his conformity left undiſcovered! And on this occaſion, *Theophilus*, I muſt mention one thing, that I have obſerved, which perhaps you will not think either deſpicable or impertinent; and it is, that though the people of *China* be eſteemed the moſt numerous, the moſt flouriſhing, and (very few, if any, excepted) the moſt civilized nation in the world; though amongſt them the greateſt part of preferments be attainable by verbal learning; and though they have books in their language (how well written, I know not, having never read any of them) of almoſt all kind of liberal arts and ſciences; yet I find by the late traveller in *China*, that writ the Italian hiſtory of that kingdom, and by other authors, that mention their literature, that this populous and ingenious nation, that has been ſo long ſettled in a flouriſhing condition, and more than any other people allows encouragements and recompences to learned men, has not cared to receive rhetorick into the number of their arts and ſciences; preſuming, as one may gueſs, that the confining men's expreſſions to eſtabliſhed rules would not be ſo like to enable thoſe to expreſs themſelves eloquently, that nature has indiſpoſed to do ſo, as to hinder others from expreſſing themſelves as well, as, were they left to their full liberty, they would do. I will not ſay, nevertheleſs, that our ſtrict Ciceronian rules are crutches, that may be helps to weak or lame fancies, but are clogs or burdens to ſound and active ones; but this I obſerve, that theſe Utopian laws of oratory are ſeldom rigorouſly impoſed by any, that publiſh other books, that may be examined by them; and that wiſemen, as well in the Weſt, as in the Eaſt, will not eaſily loſe good thoughts, or good expreſſions, becauſe they are not reducible to them. And this I the rather preſs, becauſe I have found but too many ſo blindly ſervile, as to imitate without diſcretion or reſerve in applauded authors, as well the bad as the good; create ſuch artiſts errors rules of art; and make one man's particular fancies, or perhaps failings, confining laws to others; and convey them as ſuch to their ſucceeders, who are afterwards bold to miſ-name all unobſequiouſneſs to their incogitancy, preſumption: as *Seneca* * tells us of divers imperfections of ſtyle, which being familiar to ſome one, who at that time hath the vogue for eloquence, are upon his ſcore copied by his imitators, and by them taught to others: as, (ſays he) when *Salluſt* flouriſhed, his ſtyle made maimed and abrupt ſentences, words ſurpriſingly miſ-placed, and an obſcure brevity paſs for ornaments. And indeed, it is not uneaſy for any man to obſerve the very weeds of cried up rhetoricians cried up for flowers of rhetorick. But having already wandered, perhaps, too far in this digreſſion, I ſhall now conclude it; and though, ſince it is for the ſcripture, and with its enemies that I am contending, I ſhall venture to do it, with minding our cardinal, and thoſe that ſo undervalue the ſcripture's ways of expreſſion, in compariſon of *Tully*'s, becauſe his books do ſo regularly expreſs the rules of eloquence; that it is no marvel they ſhould find *Cicero*'s writings to be ſo conformable to their laws of art, whilſt they frame thoſe laws of art out of his writings.

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BUT, *Theophilus*, I fear I have detained you too long in a digreſſion, whereinto I ſlipt but occaſionally, which is not ſo neceſſary to my preſent argument, but that I am content you ſhould look upon the paradox as any thing rather than an opinion or reaſoning, whereon I lay any great ſtreſs.

**The fourth anſwer to the eighth objection.**

IN the fourth place then let me repreſent to you, that there are very few, if any books in the world, that are no more voluminous, in which there is greater plenty of figurative expreſſions, than in the Bible. Though this may ſeem ſtrange, it is no more than may be made good by more than ſome hundreds of inſtances; there being few tropes or figures in rhetorick, of which numerous examples are not collectible out of the expreſſions of holy writ. I inſiſt not upon this, becauſe a bare catalogue of the rhetorical paſſages, I could enumerate, would too much ſwell an eſſay; and I am informed, that taſk hath been already proſperouſly undertaken by abler pens. Wherefore I ſhall now only ſay, that the eloquence of the ſcripture hath been highly celebrated by no ſmall number of perſons, highly celebrated for eloquence; and that many, who thought themſelves as intelligent in oratory, as thoſe that cenſure the ſcripture, have ſuſpected their own eloquence of inſufficiency worthily to extol that of the prophet *Eſay*; and ſome of them, (amongſt whom I cannot but name that excellent prince of *Mirandula*, whom even the greateſt rabbi of this age ſtyles the phœnix of his age) who after having unſatisfiedly travelled thorough all ſorts of human volumes, have reſted and acquieſced only in theſe divine ones: which will not a little recommend the ſcripture, ſince we may apply to books what an excellent poet ſays of miſtreſſes;

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And where theſe verbal ornaments are ſpared, they are not miſſed; for as there are ſome bodies ſo well ſhaped and faſhioned, that any clothes become them much better than the moſt fine and graceful would do ordinary (much judge of all eloquence, by the rules of it, that *Cicero*'s admirers impoſe on us; and confound their ſyſtems of precepts with the art of rhetorick, as if they were equivalent, or of the ſame extent. 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**The fourth anſwer to the eighth objection.**

IN the fourth place then let me repreſent to you, that there are very few, if any books in the world, that are no more voluminous, in which there is greater plenty of figurative expreſſions, than in the Bible. Though this may ſeem ſtrange, it is no more than may be made good by more than ſome hundreds of inſtances; there being few tropes or figures in rhetorick, of which numerous examples are not collectible out of the expreſſions of holy writ. I inſiſt not upon this, becauſe a bare catalogue of the rhetorical paſſages, I could enumerate, would too much ſwell an eſſay; and I am informed, that taſk hath been already proſperouſly undertaken by abler pens. Wherefore I ſhall now only ſay, that the eloquence of the ſcripture hath been highly celebrated by no ſmall number of perſons, highly celebrated for eloquence; and that many, who thought themſelves as intelligent in oratory, as thoſe that cenſure the ſcripture, have ſuſpected their own eloquence of inſufficiency worthily to extol that of the prophet *Eſay*; and ſome of them, (amongſt whom I cannot but name that excellent prince of *Mirandula*, whom even the greateſt rabbi of this age ſtyles the phœnix of his age) who after having unſatisfiedly travelled thorough all ſorts of human volumes, have reſted and acquieſced only in theſe divine ones: which will not a little recommend the ſcripture, ſince we may apply to books what an excellent poet ſays of miſtreſſes;

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WHEREFORE, *Theophilus*, whereas I have formerly acknowledged, that there are ſome witty men, that ſpeak very diſreſpectfully of the ſcripture, I hope, that if you meet with any ſuch, you will conſider, that it has among the wits as well celebrators, and admirers, as diſregarders. And that you may think this deſire of mine the more reaſonable, be pleaſed to conſider with me, that there are divers things, which ought to leſſen the authority of the diſparagers of the ſcripture, in the caſe under conſideration.

FOR firſt, how few of them, think you, are wont to read it in its originals; and how much a leſs number is there of thoſe, who both know and duly conſider all thoſe particulars repreſented in the paſt diſcourſe on the behalf of the ſcripture ſtyle? So that in a great many men of parts, their undervaluation of the ſcripture proceeds not from their having great wits, but from their not having a competent information of what can be alledged for its juſtification.

BUT though we ſhould ſuppoſe thoſe we ſpeak of not to want information, yet we may well ſuppoſe many of them not to be free from vanity and envy; there ſcarce being any fault ſo incident to great wits, as the ambition of being thought ſtill more and more ſo, and the unwillingneſs, that any compoſures but their own, or thoſe they have a hand in, ſhould be celebrated; as if all praiſes were injurious to them, that are given to any other. It need be no great wonder then, if ſo excellent a book as the ſcripture, have as well enviers, as admirers; and if there be divers, who cavil at it, and ſeem to undervalue it, out of a criminal fondneſs of the over-ambitioned title of a wit, which they hope to acquire by unherding and keeping out of the road, and owning their being able to ſlight and diſgrace that, which ſo many others reverence and venerate.

BUT thirdly, it is ſufficiently notorious, that of the oppoſers of the ſcripture there is a great part, whoſe vanity and envy, though no ſmall faults, are not their greateſt crimes; but who live ſo diſſolutely and ſcandalouſly, that the ſuſpicion cannot but be obvious, that ſuch decry the ſcripture for fear of being obliged (at leaſt for meer ſhame) to live more conformably to it. And that it were no ſlander to affirm it to be their intereſt, not their reaſon, that makes them find fault with a book, that finds ſo much fault with them; and they who are ſenſible of the truth of that of our Saviour, where he ſays, *That many love darkneſs rather than light, becauſe their deeds are evil*; and that *he that doth evil, hateth the light, neither cometh to the light, leſt his deeds ſhould be reproved*; will not be much moved to find conſcious malefactors find fault with the ſtatute-book, but will rather look upon theſe ſinners cenſures of the ſcripture, as apologies they judge neceſſary to palliate their ſins, or as acts of revenge, for their being expoſed in all their deformity to the eyes of the world, and of their own conſciences, in the Bible; and conſequently will be inclined to think, that their

John iii. 19, 20.

irreligious expreſſions do rather ſhew what they would have men believe of them, than what they believe of the ſcripture, by ſeeming to ſlight which, they hope to have their vices imputed rather to a ſuperiority of their reaſon over that of others, than a ſervitude of their reaſon to their paſſions

A long digreſſion againſt prophaneneſs, as it relates to the ſcripture.
Pſ. xxxix. 3.

[HERE I thought to paſs on to another argument, but (to expreſs my ſelf in *David*'s words) *While I was muſing, the fire burned*, and my zeal for the ſcripture, together with the charity it has taught me to exerciſe even towards its oppoſers, ſuffers me not, with either ſilence or languid reſentments, to ſee how much that incomparable book loſes of the opinion of leſs diſcerning men, upon the account of their diſreſpects, who are (whether deſervedly or not) looked upon as wits. And therefore to what I have repreſented to invalidate the authority of theſe few perſons, otherwiſe truly witty, that undervalue the ſcripture, I am obliged to add, that beſides them, there is a number of thoſe, that ſlight the ſcripture, who are but looked upon as wits, without being ſuch indeed; nay, who, many of them, would not be ſo much as miſtaken for ſuch, but for the boldneſs they take to own ſlighting of the ſcripture, and to abuſe the words of it to irreligious ſenſes, and perhaps paſſing from the impudence of perverting inſpired expreſſions, to deliver obſcene thoughts. But to knowing and ſerious men, this prevaricating with the ſcripture will neither diſcredit it, nor much recommend the prophane prevaricator: for a book's being capable of being ſo miſ-uſed is too unavoidable to be a diſparagement to it. Nor will any intelligent reader undervalue the charming poems of *Virgil* or of *Ovid*, becauſe, by ſhuffling and diſguiſing the expreſſions, ſome French writers have of late been pleaſed out of rare pieces to compoſe whole books of what they call, *Vers Burleſques*, deſigned by their ridiculouſneſs to make their readers ſport: and on the other ſide, to abuſe diſmembred words and paſſages of any author to meanings he never dreamed of, is a thing ſo eaſy, that almoſt any man may have the wit to talk at that prophane rate, that will but allow himſelf the ſaucineſs to do ſo. And indeed experience ſhews, that if this vice itſelf do not make its practices ſuſpected of the being neceſſitous of the quality they put it on to be thought maſters of, yet at leaſt perſons intelligent and pious will not be apt to value any diſcourſe as truly witty, that cannot pleaſe the fancy without offending the conſcience, and will never admire his plenty, that cannot make an entertainment, without furniſhing out the table with unclean meats; and conſidering perſons will ſcarce think it a demonſtration of a man's being a wit, that he will venture to be damned to be thought one. And that which aggravates theſe mens prophaneneſs, and leaves them excuſeleſs in it, is, that there are few of theſe *fools*, (for ſo the wiſe-man calls them) that *make a mock of ſin*; *that have ſaid in their hearts, that there is no God*; or that the ſcripture is not his word; their diſreſpect to the ſcripture ſpringing from their vanity, not their incredulity. They affect ſingularity, for want of any thing elſe that is ſingular; and finding in themſelves ſtrong deſires of conſpicuouſneſs, with ſmall abilities to attain it, they are reſolved with *Eroſtratus*, that fired *Diana*'s temple, to be talked of for having done ſo, to acquire that conſiderableneſs by their ſacrilege, which they muſt deſpair of from their parts. And indeed there want not many, who have ſo little wit, as to cry up all this ſort of people for great wits. And as withies, whilſt they are ſound, grow unregarded trees, but when they once are rotten, ſhine in the night; ſo many of theſe pretenders, whilſt they were not very prophane, were (and that juſtly) eſteemed very dull; but now that their parts are abſolutely corrupted and perverted, they grow conſpicuous, only becauſe they are grown depraved. And I ſhall make bold to continue the compariſon a little further, and obſerve, that as this

Pſ. xiv. 1.

rotten wood ſhines but in the night; ſo many of theſe pretenders paſs for wits but amongſt them, that are not truly ſo. For perſons really knowing can eaſily diſtinguiſh betwixt that, which exacts the title of wit from our judgments, and that which but appears ſuch to our corruptions. And how often the diſcourſe we cenſure is of the latter ſort, they need not be informed, that have obſerved, how many will talk very acceptably in derogation of religion, whom, upon other ſubjects, their partialleſt friends acknowledge very dull; and who are taken notice of for perſons that ſeldom ſay any thing well, but what it is ill to ſay. And queſtionleſs, there is no ſmall number of theſe ſcorners, whoſe cenſures of the ſcripture's ſtyle are little leſs guilty of preſumption than profaneneſs. I have of late years met with divers ſuch vain pretenders, who bluſh not to talk of rhetorick more magiſterially than *Ariſtotle* or *Tully* would; and ſuperciliouſly to deride, in compariſon of their own writings, and theirs who write like them, not the Bible only, but the moſt venerated authors of antiquity; and, to uſe *Aſaph*'s words; *They ſpeak loftily, they ſet their mouth againſt the heavens, and their tongue walketh thorough the earth:* they ſpeak arrogantly and cenſoriouſly both of God and men; whilſt themſelves oftentimes underſtand no tongue but their mothers; and are ſtrangers enough to rhetorick, not to know the difference betwixt a trope and a figure, betwixt a proſopopœia and a metaphor, or betwixt a climax and a metonymy. Nor is our wonder like to ceaſe, to find theſe tranſcendent wits, (as they are pleaſed to think themſelves) ſo undervalue the ſcripture, by conſidering the rare compoſures they deſpiſe it for; theſe being commonly no other than ſome drunken ſong or paltry epigram, ſome fawning love-letter, or ſome ſuch other flaſhy trifle, that doth much more argue a depreſſed ſoul, than an elevated fancy. Some of theſe gallants by their tavern ſongs uſe the muſes like anchovies, only to entice men to drink: another with more ſolemnity and applauſe makes the muſes (what the French call) the confidents of his amours, proſtitutes his wit to evince and celebrate the defeat of his reaſon, and never conſidering how apt ſelf-love makes us to magnify any thing that magnifies us, is proud to have wit aſcribed him by as bribed as incompetent judges of it; and takes it for as high a proof as deſirable a fruit of eloquence, to perſuade a vain miſtreſs, that ſhe is handſome and adored, to whom it were eloquence indeed to be able to perſuade the contrary. Divers of the Jews are wont to mention the names of deceaſed ſinners, with that brand taken out of the *Proverbs*, *May the name of the wicked rot*; but as the filthieſt ſwine after their death are ſalted, and the gammons made of their fleſh are ſerved in, all ſtuck with bays; ſo divers, that have lived notorious Epicures, have too often, after their death, not only their names ſalted (not to ſay embalmed) with flattering epitaphs, and (I wiſh, ſeldomer, as flattering) funeral ſermons; but have their drunken or luſtful rhimes extolled with ſuch elogies by their ſurviving reſemblers, that not only good Chriſtians, but good poets cannot but grieve and bluſh, thus to ſee bays, that ſhould be appropriated to, and crown that heavenly gift called poetry, when mindful of its dignity and extraction, it indears to us by our fancies truths, that ſhould have an influence on our affections, (by cloathing excellent thoughts in ſuitable and winning dreſſes) proſtituted and degraded to make wreaths for thoſe, who have no better title to them, than a few ſenſual rhimes, where the dictates of *Horace* are as little conformed to, as the example of *David*; and the laws of the art little leſs violated than thoſe of religion. It is pleaſant to obſerve, in how many of ſuch copies of verſes, the themes appear to have been made to the conceits, not the conceits for the themes; how often the words are not ſo properly the clothes of the matter, as the matter the ſtuffing of the words; how frequently ſublime nonſenſe paſſes for ſublime wit; and (though, according to my notion of it, that is

Pſ. lxxiii. 8, 9.

indeed true wit, which it is more eaſy to underſtand, than it is not to admire it) how commonly confuſed notions, and abortive or unliked conceptions, are in exotick language, or ambiguous expreſſions, expoſed to the uncertain adoption of the courteous reader; which the writers are emboldened to expect favourable, by finding men once thought (whether deſervedly or otherwiſe) lofty wits, to have ſo often the luck of parrots, and of thoſe that talk in their ſleep, who are not ſeldom underſtood by others, when they do not underſtand themſelves. And very much of kin to their verſes is their proſe. For though I am far from denying, that thoſe, that have ſtore of wit, may expreſs ſome of it in an addreſs to a great man, or in writing to a miſtreſs; yet as for ſuch prophane perſons I am now ſpeaking of, who rather would be thought wits, than are ſo, it is eaſy to diſcern, that very many of their almoſt as much flattered as flattering letters of love and compliment are but prologues to, and paraphraſes of the ſubſcription, (your humble ſervant.) Though love be univerſally thought to make the fancy ſoar, (lovers like ceeled pidgeons flying the higher for having been blinded) and though even the wiſer obſerve, that like war, which is wont as well to raiſe ſoldiers of fortune, as to ruin men of fortune, love warms and elevates leſſer wits, though it too often infatuate the great ones: yet a witty lady did not ſcruple to ſay frequently, that give her but leave to bar half a ſcore words, and ſhe would undertake to ſpoil all the fine letters of our amorous gallants. I applaud not the ſeverity of this lady, and think her challenge reliſhes as much of vanity as ſkill; but yet, to expreſs the ſenſe of theſe few words, [I deſire you ſhould think I can write well, am a civil perſon, and your humble ſervant] being the drift and ſubſtance of moſt of theſe ceremonial papers; theſe (oftentimes as tedious as ſervile) amplificators, with all their empty multiplicity of fine words, do but, like market-people, pay a piece in twenty ſhillings. In wits not bleſſed with ſolid reaſon and learning, (that is, in moſt readers) fancy being the predominant faculty, makes them reliſh thoſe writings moſt, where fancy unrivalled reigns. And therefore, though I dare not ſay, that it requires no great parts for thoſe to write high and acceptable compliments, that think nothing fit to be endeavoured in compliments, but to make them acceptable by making them high enough; (flattery and prophaneneſs ſeeming in ſuch compoſures what ſpots are in leopards, blemiſhes, that make a great part of their beauty) or for a flatterer to perſuade thoſe vain perſons, that will readily believe a man, even when he doth not believe himſelf: yet ſure it gives much latitude and liberty to a writer, not to be obliged to believe what he ſays, not ſay but what he thinks either will be or ought to be believed. And truely, they that exerciſe their pens on either ſort of themes (I mean thoſe that require only new or pleaſing fancies, and ſmooth language, and thoſe that require learning and knowledge pertinently and handſomely expreſt) do, I doubt not, find it much leſs difficult for writers to delight, where they propoſe themſelves no higher end, and ſcruple at nothing they judge conducible to that inferior one; than to pleaſe, where to do ſo is but a ſubordinate end, which men allow not themſelves, neither the uſe of all proper means to attain. Nor do I queſtion but ſuch perſons find it far more eaſy to write acceptably on ſubjects, where they are not tied to ſpeak either reaſon or truth; than to write well on a theme, where men are confined to write nothing but what they judge uſeful, and what they can make good, as conſidering that they may be called to account by men for what they publiſh, if not by God, both for their own time and that of their readers. And indeed, when I compare the moſt applauded trifles of theſe undervaluers of the ſcripture ſtyle, with the celebrating diſcourſes of it extant in the learned writings of St. *Auſtin*, St. *Hierom*, *Tertullian*, *Lactantius*, *Chryſoſtom*, *Mirandula*, and others, whoſe penetrant and powerful arguments defeat not God's enemies, as *Samſon* did the

Judg. xv. 15. Philiſtines, *with a jaw-bone of an aſs*, nor as *Shamgar with an ox-goad*, (I mean with Judg. iii. 31. blunt and deſpicable weapons) but as *Elias* did, *with fire from heaven*; and whoſe 2 Kings i. 10. apologetical defences of the ſpiritual *Jeruſalem* are glittering and ſolid, as the wall of the heavenly *Hieruſalem* is deſcribed to be of jaſper, *and the foundations of the wall* Rev. xxi. 10, 18, 19. *garniſhed with all manner of precious ſtones*: when I compare, I ſay, the compoſures of our frothy cenſurers with thoſe of the ſacred orators; methinks I diſcern ſuch a difference betwixt them, as I have obſerved betwixt thoſe juſtly admired ſtatues I have ſeen in the Capitol, and the larger ſort of babies that we find in the exchange. For the former, beſides their vaſtneſs, are ſo recommended by the worth and permanency of their matter, the excellency of their workmanſhip, and the nobleneſs of what they repreſent, that they are moſt prized by the beſt artiſts, and time is not only unable to conſume them, but ſtill increaſes mens value of them; whereas the latter are little trifles, ſcarce welcome to any but children in underſtanding, and admired only for a gaudy effeminate dreſs, which will quickly either be ſullied or worn out; and a faſhionableneſs which within a ſhort while will perhaps be ridiculous. But ſuppoſing at length, that the profane aſpirer ſhould be ſo lucky, or ſo ſucceſsful, (for happy I cannot think it) as to attain the ſo criminally courted notedneſs, yet will he have no great cauſe to boaſt the purchaſe, when he ſeriouſly conſiders, that the devil, who ſeduces other ſinners like men, with current coin or ſparkling jewels, (ſomething that either advantages their intereſts, or delights their ſenſes;) hath enveigled him, like a child, with a whiſtle; a trifle that only pleaſes with a tranſient and empty ſound; and, that fame is a bleſſing only in relation to the qualities, and the perſons that give it, ſince otherwiſe the tormented prince of devils himſelf were as happy as he is miſerable; and famouſneſs unattended with endearing cauſes is a quality ſo undeſirable, that even infamy and folly can confer it; as *Momus* is little leſs talked of than *Homer*; the unjuſt *Pilate* is more famous than *Ariſtides* the juſt; and *Barabbas* his name is ſignally recorded in ſcripture, whereas the penitent thief is left unmentioned. And ſure the higheſt favours, that applauſe can impart, and the being (though never ſo loudly) cried up for a wit, will hardly ſo repair the puniſhment of prophaneneſs, but that its wretched ſufferer will find but ſmall ſatisfaction in having his name celebrated in other books, whilſt it is blotted out of that of life. And as for thoſe (you know who I mean) that aſpiring to poſtume glory, endeavour to acquire it by irreligious writings deſtinated not to ſee the light, till their authors be gone to the region of darkneſs; I cannot but admire to ſee an ambition, that projects beyond the grave, ſtep ſhort of heaven; and cannot but think thoſe wits the greateſt fools, who, to tempt praiſes they ſhall never hear, provide themſelves torments that they ſhall ever feel. For though prophaneneſs, by thoſe that are guilty of it, be too often thought but a ſmall ſin, becauſe they look upon it but as a verbal one; yet I could eaſily repreſent it under another notion, if I would here repeat what I have diſcourſed, touching indulgence to reputedly ſmall and verbal ſin in another paper, from which though I will not now tranſcribe any thing, yet I cannot but wiſh it were well conſidered, how affronting ſpeeches concerning God's word are like to be looked Jude ver. 14, 15. upon in that great day, when (to borrow St. *Jude*'s terms) *the Lord ſhall come with ten thouſands of his ſaints, to execute judgment upon all, and to convince all that are ungodly among them,* (not only) *of all their ungodly deeds, which they have ungodlily committed,* (but) *alſo of all their hard ſpeeches, which ungodly ſinners have ſpoken againſt him.* And indeed theſe preſumed peccadillos, though oftentimes in health and proſperity they appear not to us to blemiſh much our conſciences, yet when in our Zeph. i. 12. diſtreſſes, or at the approaches of death, God comes, as the prophet ſpeaks, *to ſearch men's hearts as it were with candles, and puniſh the men that are ſettled upon their lees,* (which whilſt a liquor is, it may look clear, and be taken for defecated, but a little agitation of the veſſel ſtrait makes it troubled and muddy;) they appear in a terrifying form. For as paper written upon with juice of lemons may wear white (the livery of innocence) whilſt it is kept from the fire; but being held to it, black lines do preſently appear: ſo out of many conſciences, that ſeem clear in proſperity, the fire of adverſity draws out the latent blackneſſes, and makes us read things undiſcerned there before. And queſtionleſs, if, as the ſcripture informs us, *there are ſins, whoſe cry is able to reach heaven*; ſo loud a crime as the prophaneneſs I am now ſpeaking of, is likely to do more than whiſper there; eſpecially, ſince it is much to be feared, that many of theſe ſcoffers (as they ſeem to be called in the ſcripture) which they bear witneſs to, by cavilling at it, do *rebel againſt the light*, and *kick againſt the pricks* of their own conſciences: ſuch a crime, I ſay, will be ſo far from whiſpering in heaven, that it will rather give an alarm, that will rouſe up provoked juſtice; whoſe inflictions, like ſtones tumbled down from the towers of an aſſaulted place, the longer they are in falling on men, the more fatally they oppreſs them. In which regard perhaps, the feet of our Saviour in the Apocalypſe are deſcribed to be like unto fine braſs, as if they burned or glowed in a furnace; to intimate, that though he be very ſlow in his march to deſtroy the wicked, yet he is as ſure, when once he pleaſes to tread them under foot, to cruſh and conſume them. If there be no injury, that more exaſperates than contempt, nor no contempt, that more provokes than that, which offends directly and immediately, (the affronters thereby proclaiming, that they are neither aſhamed nor afraid of angering) how provoking may we think that crime, which makes God the ſubject of our deriſion; and that with ſo little circuition, as to abuſe that word, which he ſo ſolemnly declared his mind by to mankind? *Plutarch*, to manifeſt how much ſome idolaters did more incenſe the Deity than ſome artiſts, tells us, he ſhould eſteem himſelf leſs injured by the man, that ſhould doubt or deny, that there was ever any ſuch man as *Plutarch*, than by him, that ſhould affirm, that there was ſuch a one indeed, but that he was an old fellow, that uſed, like the poet *Saturn*, to devour his children; and was guilty of thoſe other crimes imputed by the Heathen to their gods. Upon a like account, we may eſteem God leſs provoked by their unbelief, that doubt or reject the ſcripture, than by their prophaneneſs, that make ſo ſacrilegiouſly bold with it; ſince the latter impute to God the inditing of what they endeavour to make men think fit to have ſport made with it. This of prophaneneſs is ſo empty and unprofitable a ſin, that it ſcarce gets the practiſer any thing but an ill name amongſt good men upon earth, and a worſe place amongſt bad men in hell; by making his enmity to piety ſo malicious and ſo diſintereſted, that he will endeavour to do religion harm, though it be to do himſelf no good. He is ſuch a volunteer ſinner, that he hath neither the wit nor the excuſe of declining his conſcience in compliment to his ſenſes; and though he ever makes but an ill bargain, that gets in hell to boot, yet thoſe I would reclaim, come far ſhort of the comparative wiſdom of their folly, who to gain ſo conſiderable (though yet over-purchaſed) a poſſeſſion as the whole world, ſhould part with their own ſouls. And ſure a ſin, that is injurious to God's glory, and is apt to ſubvert (what he and good men prize next) the dearly purchaſed, immortal, and invaluable ſouls of men, and to *deſtroy them for whom Chriſt died*; will not by being verbal, be protected from being heinous. And to thoſe that practiſe it, I ſhall recommend the latter half of the epiſtle of *Jude*; which, though it ſeem properly to relate to the Gnoſticks, or Carpocratians of his time, will deſerve a trembling attention from thoſe that revive the ſins there condemned, in ours; and who would do well, by ſeaſonably conſidering the fate there threatened to their predeceſſors, to tremble at their crime.

Gen. xviii. 21.

2 Pet. iii. 3.

Jude ver. 17, 18.

Rev. i. 15.

Rom. xiv. 15.

But for fear of loſing it, I ſhall not ſpend more time in endeavouring to diſabuſe our
ſcorners; whom I ſhould have left to the quiet enjoyment of their unenvied ſelf-admiration,
had not their deſpiſing the ſcripture, upon a preſumption of their own
1 Kings xii. matchleſs wit, (like *Jeroboam*, that forſook that incomparable ſtructure, the temple,
28, 32. where God did ſo glorioſly and peculiarly manifeſt himſelf to men, to worſhip calves
of his own making) engaged me, in conformity to the wiſe man's counſel in ſuch
Proverbs caſes, to *anſwer the fool according to his folly, leſt he be wiſe in his own conceit.* For my
xxvi. 5. reproofs are addreſſed to thoſe called wits, but as they are traducers and undervaluers
of the ſcripture, not as they either pretend to, or enjoy, a quality, which I have the
juſtice to eſteem, though not the happineſs to poſſeſs; and which my value for it, and
my charity for men, makes me troubled to ſee arrogated by many that want it, and by
too many, that have proſtituted it to gratify other people's pride, or their own luſts.
How* much happier were it for perſons of choice parts to employ them, as *Bezaleel*
Exod. xxiii. 3, 4, 5, &c. and *Aholiab* did theirs, in working for the ſanctuary; in aſſerting the embelliſhing
divinity? The ſtructure will not alone deſerve the ſkilfulleſt hand, but though it reject
not goat's hair, and coloured badger's ſkins, will admit not only purple and fine
twined linen, but gold, ſilver and precious ſtones; the richeſt ornaments, that learning
and eloquence can grace theology with, being not only merited by that heavenly
ſubject, but being applicable to it, as much to their own advantage as to that
of their theme. We ſee how ambitious men are, to leave a good name behind
them, and appear in the habit of virtue to their own after time: witneſs the artifices
and hypocriſy men generally veil or diſguiſe their ſins with; and the flattering epitaphs,
with which ſo many vicious perſons endeavour to convey themſelves to the good
opinion of poſterity. Now they that write piouſly, as well as handſomely, have the
advantage of getting themſelves the reputation as well of virtuous as of able men,
and beſides that double recompence may expect a third (tranſcending both) in heaven,
Dan. xii. 4. where they that (in the true ſcripture ſenſe) *be wiſe, ſhall ſhine as the brightneſs of the
firmament, and they that turn many to righteouſneſs, as the ſtars for ever and ever.* It
is the general complaint and grief of perſons truly zealous, that there are many more
wits and grandees now-a-days, who, by perverting God's gifts to the ſervice of
idols (of pride or pleaſure) of their own ſetting up, reſemble the degenerate Jewiſh
Hoſ. ii. 8. church, of whom God complains by *Hoſea*, that *ſhe did not know, that he gave her the
corn and wine and oil, and multiplied her ſilver and her gold, which they prepared for*
Baal; than that (by an humble dedication of their choiceſt abilities to God's ſervice)
1 Chron. xxix. imitate holy *David* and his princes; who having conſecrated their gold and ſilver and
precious ſtones, towards the enriching and embelliſhing of the temple, perfumed that
vaſt offering with this acknowledgment to God; *All things come of thee, and thine own*
ver. 14. *have we given thee.* But though now I know divers great perſons and great wits
amongſt us, who very unmindful of that text, *What haſt thou that thou didſt not receive,*
1 Cor. iv. 7. like thoſe ungrateful clouds that obſcure the ſun that raiſed them, oppoſe the
glory of that God, who elevated them to that height: yet I do not abſolutely deſpair,
that as God hath been pleaſed to make uſe of ſeveral royal pens for the tracing of his
word, and to make a perſon, learned in all the wiſdom of the Egyptians, his firſt
ſecretary; ſo he will one day engage both the grandees and the wits to ſtrive to expiate,
by their devotion and ſervice to the ſcripture, the injuries, that irreligious
parts and greatneſs have done it. I will not tell you, *Theophilus*, that an early ſtudy
of religion would gain to its party moſt of thoſe many wits, that will be ſure to con-

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* An appendix to the former digreſſion, inviting one ſort of witty men to make amends for the prophaneneſs of another.

tend for whatever opinion is expreſſed by the wittieſt things they can ſay. But I will tell you, that a particular conſideration, that makes me wiſh to ſee witty writers more generally employ their pens on the behalf of religion, is, that the ſervices they do it, endear it to them: for as *Machiavel* ſmartly obſerves, and as the love of parents and nurſes to children may evince, *La natura de gli huomini è coſi obligaſi per li beneficii che eſſe fanno, come per quelli che eſſi ricevono.* It is natural to men, to be as well engaged by the kindneſſes they do, as by thoſe they receive. Nicholo Machiavelli nel libro del Principe, c. 10. And for the encouragement of the poſſeſſors of great parts, to employ them on religious themes, ſuch as the holy ſcripture; I ſhall repreſent to them, that even that immortality of name, which worldly writers (for the moſt part) ſolely aim at, is not by pious writers leſs found for being laſt ſought: their theme contracts not their fame by a true diminution, but only by compariſon to a greater good: their looking upon their own glory but as an acceſſion to God's, not hindering others from praiſing that wit and eloquence they praiſe God with; as beauty made it ſelf admirers, though in veſtals, and a rare voice may raviſh us with a pſalm; or as the jewels that adorned it, ſhone with their wonted luſtre on *Aaron*'s breaſt-plate; yes, *as godlineſs is profitable unto all things, having promiſe of the life that now is, and of that which is to come; and the hundred fold now in this time*, is very conſiſtent with the *eternal life in the world to come:* 1 Tim. iv. 8. Mark x. 30. ſo is it very poſſible for the ſame pious writer to have his name written at once in both thoſe immortal books of life and fame; and (like the inſpired poet, holy *David)* wear as well here a crown of laurel, as hereafter, τὴν ἀμαράντινον τῆς δόξης στέφανον, that unfading crown of glory St. *Peter* ſpeaks of. 1 Pet. v. 4. And though we are too generally now-a-days ſo ſinful, that we ſcarce reliſh any compoſure, that endeavours to reclaim us from being ſo; yet leſs licentious and more diſcerning times, (which may be, perhaps, approaching) will repair the omiſſions and faſtidiouſneſs of the preſent, by an eminent gratitude to the names of thoſe, that have laboured to tranſmit to others, in the handſomeſt dreſs they durſt give them, the truths themſelves moſt valued. And I obſerve, that though *Solomon* himſelf delivered ſo many thouſand ſongs and proverbs, and the nature of beaſts, birds, reptiles, and fiſhes, together with the hiſtory of plants from the *cedar of* Lebanon, *even to the hyſſop that ſpringeth out of the wall*; 1 King iv. 31, 32, 33. yet thoſe three only treatiſes, deſigned peculiarly for the inſtruction of the church, ſurvive their loſt companions. And as anciently the manna, which the Iſraelites gathered to employ in their domeſtic uſes, laſted not unputrified above a day or two; but that, which they laid up in the ſanctuary to perpetuate or ſecure God's glory, continued whole ages uncorrupted: ſo the books written to ſerve our private turns of intereſt or fame are oftentimes ſhort-lived; Exod. xvi. ver. 20, 33, 34. when thoſe, conſecrated to God's honour, are, for that end's ſake, vouchſafed a laſtingneſs and kept from periſhing. And thoſe many dull and uneloquent gloſſes and expoſitions of the ancient Jews, that the merit of their theme hath preſerved for ſo many ages, may aſſure us, that the ſcripture doth often make their names and writings that illuſtrate it, partakers of its own prerogative of immortality. Not to mention that (according to that of the Pſalmiſt, Pſal. cxix. 99. *I have more underſtanding than all my teachers; becauſe,* כי, *thy teſtimonies are my meditation)* ſuch an employment of parts doth oftentimes invite God to increaſe them; Mat. xxv. 28. as he that had moſt talents committed to him, for improving them to his Lord's ſervice, was truſted with more of them; and he, who employed ſome few cups of his wine to entertain our Saviour, had whole veſſels of his water turned into better wine. John ii. to the tenth verſe incluſively. Certainly, tranſcendent wits, when once they addict themſelves to theological compoſures, improve and grace moſt excellently themes ſo capable of being ſo improved. They need ſmall time to ſignalize their pens; for poſſeſſing already in a ſublime degree all the requiſites and appropriates of rare writers, they need but apply that choice knowledge and charming eloquence to divine ſubjects to handle them to admiration;

as *Hiram* ſucceſsfully uſed the ſkill he had learned in *Tyre*, in the building and adorning of God's temple; and *Jephtha* victoriouſly employed the military gallantry and art, that had made him conſiderable in the land of *Tob*, in defending the cauſe, and defeating the enemies of God. Of this truth the primitive times afford us numerous and noble inſtances; but eſpecially that ſtupendous wit St. *Auſtin*, (whom I dare oppoſe to any of the wits, that have dared to oppoſe the ſcripture) the productions of whoſe wit in his unregenerate ſtate, and after his converſion to the catholick faith and piety, oblige me to reſemble him to *Aaron*'s rod; which (ſuppoſing the truth of their opinion, that think it to be the ſame that *Moſes* uſed) whilſt it was employed abroad, did indeed for a while work wonders, that made it much admired; but when once it came to be laid up in the tabernacle, unconfined to the uſual laws of other plants, it ſhot forth and afforded permanent fruit in a night. But, *Theophilus*, to recover my ſelf at length from my over-prolix digreſſion, I muſt remember, that it was objected, that as well divers great princes and great ſtateſmen, as many great wits, diſ-eſteem, or at leaſt neglect the ſcripture. And indeed, though I am ſorry it cannot, yet it muſt not be denied, that notwithſtanding all the prerogatives of the Bible, there needs not much acquaintance with great men, to ſhew many of them, that though they deny not God to be the author, deny themſelves the bleſſing of being readers of it, ſome out of lazineſs, and others out of pride; both which lurk under the pretext of multiplicity of important avocations. But ſince your quality, *Theophilus*, and ſtation in the world, may either make you need to be armed againſt this temptation, or give you opportunities to aſſiſt thoſe that are endangered by it, give me leave, on this occaſion, to tell you, that thoſe grandees, that pretend want of leiſure for their neglect of the reading of the ſcripture, muſt be able to give a rare account of all the portions of their time, to make thoſe paſs for a miſ-employment of it, that are laid out towards the purchaſe of a happy eternity; which it is not over-modeſt for thoſe to expect from God, that grudge him the rent of that time, of which they are but his tenants at will. But to manifeſt how unlikely this pretence is to paſs current; I ſhall repreſent, that in the ſelf-ſame chapter, where God faſhions a king fit to govern his own people, he enjoins concerning the book of the law, that *it ſhall be with him, and he ſhall read therein, all the days of his life*; which the next verſe intimates ſhall be thereby prolonged. And indeed, it often happens, that as *Samuel*'s barren mother for lending one of her children freely unto the Lord, was bleſt with many others; ſo the days conſecrated to God's ſervice rather improve than impoveriſh our ſtock of time. Nay, the king was (in that place of *Deuteronomy)* not only obliged to read the law, but to write it too: upon which ſubject, if I miſ-remember not, the learnedeſt of the Rabbies tells us, that the king (as indeed God uſually charges eminence of place with eminence of piety) was bound to write it out himſelf, and that, as king. For though before his aſcending the throne, as any other Iſraelite, he had a tranſcript of his own writing; yet was there annexed to the acquiſt of the regal ſcepter, a duty of copying with the ſame hand that ſwayed it. To *Joſhua* both a general and a judge, who was to wield the ſwords both of *Aſtræa* and of *Bellona*, to govern one numerous people, and conquer ſeven; the words of God are very remarkable: *This book of the law ſhall not depart out of thy mouth, but thou ſhalt meditate therein day and night, that thou mayeſt obſerve to do according to all that is written therein*; *for then thou ſhalt make thy way proſperous, and then thou ſhalt have good ſucceſs. David* was a ſhepherd, a conqueror, and a king, and had certainly no unfrequent diſtractions, both before he came to the crown, (whilſt he lived a deſpiſed younger brother, an envied courtier, a diffident fugitive, and a diſtruſted captain) and after, whilſt he wore, loſt, and regained it: but how little the time employed in the ſtudy of the ſcripture prejudiced his ſecular

1 Kings vii. 13, 14, &c.

Judg. xi.

Num. xvii. 4, 8.

Deut. xvii. 18, 19.

Ver. 20.

1 Sam. ii. 20, 21.

Ver. 18.

Rambam, or Rabbi Moſes Ben-Maimon.

Joſh. i. 8.

affairs, his ſtory and ſucceſſes may atteſt; and how large a portion of his time that ſtudy ſhared, you may be plentifully informed by himſelf, and ſave me the tranſcribing much of the book of *Pſalms*. He gathered bays both on *Parnaſſus* and in the field of honour; and equally victorious in duels and in battles, his exploits and his conqueſts were ſuch, as (tranſcending thoſe in romances almoſt as much in their ſtrangeneſs as their truth) needed an infallible hiſtorian to exact a belief, their greatneſs and their number would diſſuade. He added to his regal crown of gold two others (of bays and laurel) which his ſucceſsful ſword and numerous pen, making him both a conqueror and a poet, gained him from victory and the muſes. And yet for all this greatneſs and this fame, and that multitude of diſtractions that ſtill attends them, the (then extant) ſcripture was ſo unſeveredly his ſtudy, and he ſo duly matched in his practice what the Apoſtle couples in his precept, *diligence in buſineſs*, and *fervency in ſpirit*, that it is not eaſy fitlier to reſemble him, than to the winged cherubims in the old tabernacle, whom all the gold and jewels, that glittered about them, and all the clouds of incenſe fumed before them, could never divert from a fixed poſture towards the ark of the teſtimony, that contained the law, and the mercy-ſeat that repreſented Chriſt. And indeed, it is a ſaying equally ancient and true, that none ſhould know (things better and) better things than princes; for their virtues and their vices participate the eminence and authority of their condition; and by an influential exemplarineſs, ſo generally faſhion and ſway their ſubjects, that as we find in ſacred ſtory, that the Jews ſerved God or *Baal* as their kings did, ſo profane hiſtory tells us, that *Rome* was warlike under *Romulus*, ſuperſtitious under *Numa*, and ſo ſucceſſively moulded into the diſpoſitions of her ſeveral princes; ſubjects, all the world over, being apt to think imitation a part of the duty of obedience; and being generally but too ſenſible of the requiſiteneſs of their being like their prince to the being liked by him. A ſtate, like *Nebuchadnezzar*'s myſterious image, ſhould have the head of gold; and the inferior members of a value proportionate to their vicinity to that nobleſt part. When once I ſhall ſee ſuch monarchies and common-wealths no rarities, and ſee the addictedneſs of princes to the ſtudy of ſcripture further the ulterior accompliſhment of that part of it, which once promiſed God's people, *that kings ſhould be its nurſing fathers, and their queens its nurſing mothers*; I ſhall expect to ſee the golden age elſewhere than in poets dreams. For I take not abſoluteneſs to be like a plague, whoſe almoſt boundleſs power is confined to do miſchief; but I eſteem ſovereignty little leſs applicable and effectual to good than ill. *Trajan* and *Conſtantine* were as great and publick bleſſings, as *Nero* or *Caligula* were miſchiefs; and virtue on a throne hath not a much leſs imperious influence, than crowned vice. And accordingly I ſhall permit my good wiſhes for mankind to turn expectations, when I ſhall generally ſee ſovereigns nobly contend for as great a ſuperiority over each other by their virtues, as they poſſeſs over their ſubjects by their fortune; when I ſhall ſee potentates make uſe of *Mars*'s ſword but to reſtrain others from abuſing it; and kings affect their reſemblance to God, leſs in his unlimitedneſs of power, than his employment of it. But, to ſtep back into my way, and leaving princes to fitter monitors, ſay ſomething to men of either great titles or employments. There is none of theſe pragmatical perſons, that will ſuffer himſelf to be ſo enſlaved to his buſineſs, but he will allow himſelf ſet times, and can daily find leiſure for eating, drinking, and other corporal refections, and frequently for recreations: and certainly, if we valued not our bodies above our ſouls, we would, in ſpite of the urgency of ſecular affairs and employments, reſerve and ſet apart ſome time to feed our ſouls with their true food, God's word; elſe we ſhall never be able to ſay of God with holy *Job*, *I have eſteemed the words of his mouth more than my neceſſary food.* I will not urge, that *Daniel*, whoſe

Rom. xii.

Deut. xxv. 18, 19, 20, 21.

Dan. ii. 31, 32, &c.

Iſa. xlix. 23.

Pſal. cxiii.

Job xxiii. 12.

whoſe vaſt abilities had a reſembling theatre, and who ſurpaſſed other ſtateſmen as Dan. vi. 3. much in the number and weight of the affairs he had to manage, as in the excellent ſpirit and dexterity, wherewith he managed them, amidſt tranſactions that buſied ſix-ſcore princes, who loaded him with a weight (of buſineſs) capable to have cruſhed Dan. ix. 2. *Atlas*, could yet find leiſure to ſtudy the prophet *Jeremy*; becauſe it will be perhaps more proper to mention, that even *Machiavel* himſelf, that ſecretary and reputed oracle of ſtate, could find time, not only to read, but to write plays, (ſome of which I have ſeen in Italian) ſuch as I would think excellent, though a perſon, from whom ſo much might be expected, had not written them. Let us not then think our buſineſs or our recreations a ſufficient diſpenſation from an employment, for which, were they inconſiſtent, they ought both to be declined; ſince it is both more concerning than the firſt, and more ſatisfying than the latter. But that, which is often the true, though ſeldom the avowed cauſe of theſe men's neglect of the ſcripture, is not their unleiſuredneſs, but their pride; which makes them think it too mean and trivial an employment for one, that is great and wiſe enough to counſel and converſe with princes; and have a vote or hand in thoſe great enterprizes and tranſactions, that make ſuch a noiſe in the world, and are the loud themes of the people's talk and wonder, to amuſe themſelves to examine the ſignifications of words and phraſes. For my part, I am no enemy to the calling of ſtateſmen; I think their profeſſion as requiſite as others in a common-wealth; and ſhould think it very injurious to deny them any part of a purchaſe they pay their care and time for: nor perhaps have I ſo little ſtudied the improvements of quiet, as to think my ſelf leſs obliged than others are to thoſe, whoſe watchings or protection affords it, or ſecures it to me. But after all this is ſaid, I love to look upon the world with his eyes, that is juſtly ſaid to *humble himſelf* (when he vouchſafes) *to behold the things that are done in heaven and in earth*; and to take meaſure of the dimenſions of things by the ſcale his word holds forth. Now in the eſteem of him, that hath made all things for Iſaiah xl. 13, 17. himſelf, and of whom his ſpirit by his prophet truly ſays, that the *nations are as a drop of a bucket, and are counted as the ſmall duſt of the balance*; nay, that *all nations before him* (are) *as nothing, and they are counted to him leſs than nothing and vanity*; the importanteſt employments are the ſtudy and glory of God. He created this vaſt fabrick of the world to manifeſt his wiſdom, power, and goodneſs; and in it created man, that it may have an intelligent ſpectator, and a reſident, whoſe rational admiration of ſo divine a ſtructure may accrue to the glory of the omniſcient and almighty architect. And as he created the world to manifeſt ſome of his attributes, ſo doth he uphold and govern it to diſcloſe others of them. The revolution of monarchies, the fates of princes, and deſtinies of nations, are but illuſtrious inſtances and proclamations of his providence. The whole earth once periſhed by water, to ſignalize his juſtice on his enemies; and the whole world ſhall one day periſh by fire, to (exerciſe that former attribute and) evidence his goodneſs to his children: for whom his faithfulneſs to his promiſes will oblige him to build a gloriouſer manſion for ſuch glorified reſidents. The angels, ſome of whom the viſions Dan. x. 13. of *Daniel* repreſent to us at the helm of kingdoms and of empires, and whoſe power is ſo great, that one of them could in one night deſtroy a force, capable, if divided, 2 Kings xix. 35. to have made half a dozen formidable armies; theſe glorious ſpirits, I ſay, whoſe nature ſo tranſcends ours, that the very devil cannot, without the aſſiſtance of virtue, deſpiſe the objects of our ambition by a ſuperiority of nature only; for all their high prerogatives and employments, think the myſteries unfolded in ſcripture worthy their παρακύψαι. 1 Pet. i. 12. bowing as well as deſire to look into; think not themſelves too eminent to be meſſengers and heralds, of which fond mortals think themſelves too eminent to read;

and (being all *miniſtring ſpirits ſent forth to miniſter to them who ſhall be heirs of ſalvation*;) diſdain not to think our inſtruction worth their concern, whilſt we diſdain a concern for our own inſtruction. Nay, the very Meſſias, whoſe ſtyle is *king of kings, and lord of lords*, though he be not recorded to have ever read but once, did yet read the ſcripture, and think it worthy his expoſitions and recommending; and well may any think that book worth the reading, that God himſelf thought worth enditing. When *Moſes* and *Elias* left their (local, not real) heaven, and appeared in glory to converſe with our transfigured Saviour on the mount; their diſcourſe was not of the government of kingdoms, or the raiſing of armies for ſubverſion of empires; or of thoſe other ſolemn trifles, which heaven places as much beneath men's thoughts as reſidence; but of (the inſpired book's chief theme) *his deceaſe, which he ſhould accompliſh at* Jeruſalem. And after that St. Paul *had been caught up to the third heaven*, and had been bleſt and refined with his ineffable entertainment there; I wonder not to find him profeſs ſo reſolutely, that he *counteth all things but loſs for the excellency of the knowledge of Chriſt Jeſus his Lord*, in whom *faith cometh by hearing, and that hearing, of the word of God*; and who addreſſes men to the ſcriptures, as thoſe which teſtify of him. And perhaps our Saviour uſed ſo frequently to conclude his divine diſcourſes with that juſt epiphonema, *he that hath ears to hear, let him hear*, but to teach us, that there is no employment of our faculties, that more deſerves their utmoſt attention, than the ſcrutiny of divine truths. That which is pretended to by this diſcourſe, is to impreſs this truth, that where God is allowed to be an intelligent and equal valuer of things, a man cannot have ſo great an employment, as to give him cauſe to think the ſtudy of the ſcripture a mean one; ſince, thus ſaith the Lord, *Let not the wiſe-man glory in his wiſdom, neither let the mighty-man glory in his might; let not the rich man glory in his riches: but let him that glorieth, glory in this, that he underſtandeth and knoweth me*. For ſure, if the knowledge of God be ſo glorious a thing, the ſtudy of that book, whence that knowledge is extracted, and where it is moſt refulgent, is not a deſpicable employment. Which ſure (to add that upon the by) it is ſomewhat injuriouſly thought by thoſe, who are ſo induſtrious and proud in profane hiſtories and other political books, to diſcover (or even gueſs at) thoſe intrigues, which commonly but tell us, by what crafty arts a knave couſened a fool. Nor (to mention this by the by) even in relation to his own profeſſion, is the ſcripture unable to recompence the ſtudy of a Chriſtian ſtateſman; for to omit the (perhaps too) extolling mention *Machiavel* himſelf makes of *Moſes* amongſt the famouſeſt legiſlators; the hiſtorical part of the Bible being indited by an omniſcient and unerring ſpirit, lays clearly open the true and genuine cauſes of the eſtabliſhment, flouriſhing and viciſſitudes of the princes and common-wealths it relates the ſtory of. Whereas other hiſtories (for reaſons inſiſted on in other papers) are liable to great ſuſpicions in the judgment of thoſe, that duly ponder the ſeveral narratives made often of the ſame tranſaction or event by ſeveral eye-witneſſes; and that the true ſecret of counſels is ſo cloſely locked up, or ſo artificially diſguiſed, that to have intereſt enough to diſcern (what ſtateſmen mind and build on) the truth and myſtery of affairs, one muſt be biaſſed and engaged enough to be ſhrewdly tempted to be a partial relator of them. But, *Theophilus*, I perceive I have ſlipped into too long a digreſſion; which yet I hope you will pardon as the effect of an indiſcreet, perhaps, but however a great concern for a perſon, to whom nature, education, and fortune have been ſo indulgent, that I cannot but look upon his condition as liable to the temptations, which either parts or employments ſingly, and much more both together, are wont to expoſe men to.

Heb. i. 14.

Rev. xvii. 14.

Luke iv. 17, &c.

Luke ix. 31.

2 Cor. xii. 2.

Phil. iii. 8.

Rom. x. 17.

John v. 39.

Jer. xix. 23, 24.

The apologiſt for and antagoniſt of Romances.

The fifth and laſt anſwer to the laſt objection.

YOU may remember, *Theophilus*, that among the anſwers, which, I told you, might be made to thoſe, that objected againſt the ſcripture, *That it is ſo unadorned, and ſo ill furniſhed with eloquent expreſſions, that it is wont to prove inefficacious, eſpecially upon intelligent readers*; the fifth and laſt was this, *That it is very far from being agreeable to experience, that the ſtyle of the ſcripture does make it unoperative upon the generality of its readers, if they be not faultily indiſpoſed to receive impreſſions from it.*

To make good this reply, I muſt take notice to you, that that part of the objection, which intimates, that intelligent readers are not wont to be wrought upon by the ſcripture, has been in great part anſwered already: for I have lately obſerved to you, that as it may be granted, that ſome witty men, who have read the ſcripture, have, inſtead of admiring it, quarrelled with it; ſo it cannot be denied, that many perſons as eminent for wit as they, have, upon reading it, entertained a high veneration for it. So that I ſee not, why the celebrations of thoſe wits, that admire it, may not counter-balance the diſ-reſpects of thoſe, that cavil at it; eſpecially if we conſider, that as to moſt of thoſe, that are looked upon as the witty diſregarders of the ſcripture, ſcarce any thing, ſo much as the vanity and boldneſs of owning that they diſregard it, makes them (but undeſervedly) be looked upon as wits.

BUT to this I ſhall now add, that whereas the objection ſpeaks of intelligent readers, the greateſt part of ſuch have not that quickneſs, which is wont to make men paſs for wits, though they may have other abilities more ſolid and deſirable: and yet that the Bible has a great influence upon this latter ſort of intelligent readers, I preſume you will eaſily believe, if you conſider how many great ſcholars, not only profeſſed divines, but others, have by their learned comments and other writings, endeavoured either to illuſtrate, or recommend the ſcripture; and how much a greater number of underſtanding and ſober men, that never publiſhed books, have evinced the ſcripture's power over them, partly by their ſermons and other diſcourſes, publick and private; and partly by endeavouring to conform their lives to the dictates of it. Which laſt clauſe I add, becauſe you can ſcarce make a better eſtimate of what power the ſcripture has upon men, than by looking at what it is able to make them part with. For not to anticipate what we ſhall ere long have occaſion to mention, let us but conſider, what numbers of intelligent perſons almoſt every age, without excepting our own (as degenerate as it is) has produced, who have been taught and prevailed with by the ſcripture, and conſiderations drawn thence, to renounce all the greateſt ſinful pleaſures, and embrace a courſe of life, that oftentimes expoſes them to the greateſt dangers and very frequently to no ſmall hardſhips.

AND indeed there is ſcarce any ſort of men, on which the ſcripture has not had notable influence, as to the reforming and proving many particular perſons, belonging to it; and to the giving them an affectionate veneration for the book, whereunto they owed their inſtruction. The accounts eccleſiaſtical hiſtory gives us of the rate, at which devout perſons, both in former and latter ages, would purchaſe the Bible, when it was dangerous and perhaps capital to be found poſſeſſed of it, would, if I ſhould here repeat them, much confirm what I ſay, and might equally create our wonder and our bluſhes. Thoſe ſorts of profeſſed Chriſtians, that ſeem the moſt evidently to be liable to temptations to neglect or diſregard the ſcripture, are either thoſe, that do, or would paſs for wits, or thoſe that live in courts; the former oftentimes thinking themſelves too wiſe to be taught, eſpecially by a book they think not eloquent, and among the latter there being but too many, whoſe pleaſures are ſo bewitching, or ſo dear to them, that they like nothing, that would divert, much leſs divorce them from their purſuit; or elſe whoſe buſineſs is ſo much, and perhaps ſo important, that they have not leiſure enough to learn, or have too much pride to think they need do it. But yet even among thoſe, that have worn crowns either of gold or bays, or (what perhaps ſome value above both) of myrtle, the Bible has not wanted votaries: for not to repeat the names of thoſe, whom I have formerly mentioned to have been as well lovers of the ſcripture, as favourites of the muſes, among the other ſort of men, *thoſe that* (to ſpeak in our Saviour's terms) *are gorgeouſly apparelled, live delicately, and are in kings courts*, there have been divers perſons, upon whom the power of the ſcripture has been almoſt as conſpicuous, as their ſtation among men. I will not mention that devout treaſurer of the *Ethiopian* queen, who even upon the high-way (whoſe length neither deterred nor tired his devotion) could not forbear to read the prophet *Iſaiah*, and inquire even of a meer ſtranger, that paſſed by alone, and on foot, the meaning of a paſſage, of whoſe ſenſe he doubted; nor will I urge any other inſtances of great men's ſtudiouſneſs of the ſcripture, afforded us by ſacred ſtory. And therefore I ſhall not preſs the example of that great and wiſe *Daniel*, whoſe matchleſs parts not only caſt upon him the higheſt employment of the world's monarchy, and diſengaged him from the ruins of it; but (what has ſcarce a precedent amongſt the very wiſeſt ſtateſmen) continued him in as much greatneſs, as ever he poſſeſſed under the predeceſſor, under the ſucceſſor; and ſuch a ſucceſſor too, as made his predeceſſor's carcaſs the aſcent to his throne: I will not, I ſay, at preſent urge the examples extant in the ſacred records of great men's ſtudiouſneſs of them, becauſe even ſecular and more recent hiſtories may inform us, that even in courts all men's eyes have not been ſo dazzled by the glittering vanities, that are wont to abound there, but that ſome of them have diſcerned, and practically acknowledged the prerogatives of ſcripture. Though I cannot ſay, that many kings have been of this number, becauſe there have been but few kings in all, in reſpect of the numbers, that compoſe the inferiour conditions of men; yet even among theſe, and in degenerate ages, ſome have been ſignally ſtudious of the Bible; ſuch was that ſixth *Edward*, who imitated the early active piety of *Joaſh*, without imitating his defection from it, and whoſe ſhort heavenly life manifeſted, how ſoon, even amidſt the temptations of courts, grace can ripen men from glory. And ſuch was that learned king, whoſe having more than perfunctorily ſtudied the ſcripture, his ſolid defence of divers of its truths againſt his miſ-interpreters have ſufficiently proclaimed to the world. Nay, even in thoſe darker times, that preceded the reformation, that excellent Aragonian king, *Alphonſus*, the honour both of his title and his times, in ſpite of his contemplations and his wars, could (as himſelf uſed to glory) ſpare time from ſtudies and his diſtractions, to read the Bible forty times with comments and gloſſes on it; being not, for all his aſtronomy, ſo taken up with contemplation of heaven, as to deny himſelf leiſure to ſtudy in his book, that made it, the ways of getting thither. Nor ſhall I forbear to mention here the laſt pope, (*Urban* the eighth) who, when being cardinal, he wanted not the hopes of becoming both temporal and eccleſiaſtical lord of that proud city, which (as if ſhe were deſigned to be ſtill, one way or other, the world's miſtreſs) doth ſtill rule little leſs of the world upon the ſcore of religion, than ſhe did before upon that of arms; in the midſt of affairs, perhaps more diſtracting than buſied moſt potentates, and honours almoſt as great as are paid to monarchs, could find room in a head crouded with affairs enough to have diſtreſſed *Machiavel*, for reflections upon the ſcripture; ſome of whoſe portions I have delighted to read in the handſome paraphraſes of his pious muſe. Which I ſcruple not to acknowledge, becauſe that though I did, which I do not, look upon every one, that diſſents from me, as an enemy; yet I ſhould be apt to think, that they can ſcarce love virtue enough, that love it not in their very enemies; congruouſly to which we

Luke vii. 25.

King James.

find that *Hannibal* had ſtatues erected in *Rome* itſelf; and though I were ſo uncharitable and ſo unexperienced as to think a man, that holds an error, can ſcarce have any good qualities; yet upon ſuch a kind of ſcore as that, which made *David* ſo angry with him, that took away the poor man's ſingle lamb, the fewer commendable qualities I ſee in my adverſaries, the more ſcruple I would make to rob them any way of them. Nor hath that very ſex, that ſo often makes divertiſements of its employments, been altogether barren in titled votaries to the ſcripture. Not to mention that Grecian princeſs, whoſe proſelyted muſe made *Homer* turn evangeliſt, how converſant that excellent mother and reſembling daughter, *Paula* and *Euſtochium*, were in the ſacred rolls, is ſcarce unknown to any, that are not ſtrangers to the writings of St. *Hierome*; for ſome of whoſe learned comments on the ſcripture we are endebted to the charitable importunity of their requeſts. And even in our times, that ſo much degenerate from the primitive ones, how eminent a ſtudent and happy a proficient in the ſtudy of the Bible, that glory of princeſſes, and the envy of the princes of her time, queen *Elizabeth*, was, her life and reign ſufficiently declare. Her ſiſter's predeceſſor, that matchleſs lady *Jane*, who had all the good qualities the beſt patriots could deſire in a queen, but an unqueſtionable title, and in whoſe ſad fate, beſides her ſex and the graces, that enamour ours of it, her country, philoſophy, virtue, and religion, did all ſuſtain a loſs, was a conſpicuous ſtudier of the inſpired books; wherein her proſpered ſeduloufneſs gave her an underſtanding much above her age and ſex, though not above her virtue. And beſides *Eudoxia*, there have been divers other perſons of the higheſt quality of that ſex, and even ſome of thoſe, on whom nature or fortune, or rather beauty or providence had conferred a ſovereignty, whom the ſplendour, the pleaſures, nor the avocations of courts could not keep from ſearching in God's word preſervatives againſt the contagion of their condition. And partly hiſtory, and partly even converſation have ſometimes with delight made me obſerve, how ſome of thoſe celebrated ladies, whoſe fatal beauties have made ſo many idolaters, have devoutly turned thoſe fair eyes, that were, and did ſuch wonders, upon thoſe ſevere writings that depreciate all but the beauty of the ſoul, from thoſe flattering aſcriptions, that deified the body. And it is not to be marvelled at, that ſuch readers as are not infidels, by reading the Bible once, ſhould be prevailed with to read it oftener; not only becauſe of the inviting excellency of what it teaches, but becauſe its author does ſo earneſtly in it enjoin the ſtudy of it, that ſcarce any can think the neglect of it no fault, ſave thoſe that are guilty of it. Nor is their ſo aſſiduous peruſal of the ſcripture ſo much to be marvelled at as commended, in perſons of that ſofter ſex, which is perhaps more ſuſceptible than ours of ſtrong impreſſions of devotion. For ſure, if we loved God, I do not ſay as we ought to love him, but as we can, and do love inferiour things, it would hugely endear the ſcripture to us, that the object of our devotion is the author of that book. When a true flame, though but for a fading object, doth once poſſeſs a fervent lover's breaſt, what a fondneſs doth his paſſion for his miſtreſs give him for all things related to her? Her reſidencies, her walks, her colours, and the leaſt trifles that have belonged to her, exact a kindneſs that's not due to trifles: though it be but for preſenting to his memory its almoſt only object, and refreſhing him with an ideal in the abſence of an immediater preſence of her. But if the favoured amouriſt be bleſt with any lines dignified by that fair hand, (give me leave to talk of lovers in their own language) eſpecially if they be kind as well as hers, how aſſiduouſly, and with what raptures do his greedy eyes peruſe them, taſting each ſeveral expreſſions with its own tranſport; and finding in each line, at each new reading, ſome new delight or excellency? This welcome letter grows ſooner old than ſtale; and all his too frequent kiſſes have worn

Eudoxia, wife to the Emperor Theodoſius.

t to tatters, (in which he preſerves it, if not worſhips too, as a relic) with ſtill freſh and ſtill inſatiate avidities doth the unwearied lover prize that (too often, either deluding or inſignificant) writing, above the nobleſt raptures of poets, and liberalleſt patents of princes: and (not to urge the ſuperſtitious devotion of our worſhippers of relicks) certainly if we had for God but half as much love as we ought, or even pretend to have, we could not but frequently (if not tranſportedly) entertain our ſelves with his leaves, which (as parrhelions to the ſun) are at once his writings and his picture; both expreſſing his vaſt and unmerited love to us, and exhibiting the moſt approaching or leaſt unreſembling idea of our beloved, that the Deity hath framed for mortals to apprehend. It was the devout quarrel of a devout father to ſome of the choiceſt compoſures antiquity hath left us, that he could not find Chriſt named there; and if, as it is not to be doubted, divers of the devout ladies I was lately ſpeaking of, were of his mind, ſure at that rate they are not ordinarily kind to the ſcripture; where the Prophets and the Apoſtles, thoſe darker and more clear Evangeliſts, do ſo unanimouſly and aſſiduouſly celebrate the Meſſiah, that when I read and confer them, I ſometimes fancy my ſelf preſent at our Saviour's triumphant entrance into *Hieruſalem*, where both *thoſe that went before him, and thoſe that followed* Mat. xxi. 9.
*after him, ſung hoſannah to the ſon of* David.——Wherefore, ſince even great wits, Mark xi.
great princes, and great beauties, have not ſtill by all thoſe temptations, to which 9.
theſe attributes expoſed them, been kept from being alſo great votaries to the ſcripture, it cannot charitably be doubted, but that in moſt ages ſome pious perſons have been able to ſay truly to God in *Jeremy*'s terms, *Thy words were found, and I did* Jerem. xv.
*eat them; and thy word was to me the joy and rejoicing of mine heart.* And if the 16.
perſons I mention have been but few, I can attribute that fewneſs but to the paucity of wiſe and good men; and as for perſons of other ranks in eccleſiaſtical ſtories, the inſtances are not ſo rare of the addictedneſs of God's children to his word, but that we might thence produce them almoſt in throngs, if we had not nobler inducements to the reading of the inſpired volume than example; and if it were not leſs to be venerated, becauſe ſo many ſaints have ſtudied it, as becauſe the ſtudy of it made many of thoſe men ſaints, (I mean not nominal, but real ones:) which we need not much wonder at, whilſt ſuch a ſaint as Saint *Paul* was aſſures us, that it is all of it 2 Tim. iii.
divinely inſpired, and improveable to all the uſes requiſite to the entire accompliſh- 16.
ment of God's ſervants. But, *Theophilus*, to return to what I was formerly diſcourſing of, the transforming power the ſcripture has upon many of its readers; I muſt ſubjoin, that though through the goodneſs of God theſe be far more numerous than the profeſſed adverſaries and contemners of the ſcripture, yet theſe make not ſo great a part of thoſe, that acknowledge the Bible, as it were well they did, becauſe both experience and our Saviour's parable have ſufficiently taught us, that good ſeed does not always fall into good ground, and that many intervening accidents may, after it has been ſown, make it miſcarry and prove fruitleſs. But when you find (as I fear you may but too often) that the ſcripture has not upon its readers, and eſpecially upon thoſe that are profane, that power, which I ſeem to aſcribe to it, and which it ought to have; you may be pleaſed to remember, that I plainly ſuppoſe in my fifth anſwer, that thoſe, to whom the ſcripture is addreſſed, muſt not be culpably indiſpoſed to be wrought upon by it. Which that profane perſons are, I preſume you will eaſily grant: for when our Saviour ſaid, that *if any man will do the will of him* John vii.
*that ſent him, he ſhall know of the doctrine, whether it be of God, or no*; he clearly 17.
intimates, that there is required a diſpoſition as well in the eye of his ſoul, (if I may ſo ſpeak) as in the object propoſed, to make a man diſcern the excellency and origination of what is taught, how valuable ſoever. St. *Paul* ſpeaking of himſelf and

other penmen and teachers of the ſcriptures, affirms, that they ſpeak wiſdom among
1 Cor. ii. 7. them, that are perfect, and (though not this world's wiſdom, yet) *the wiſdom of God in a myſtery, even that hidden one, which God ordained before the world, unto our glory.* But for theſe ſcorners, it is no wonder they ſo fruitleſly read the ſcripture, without deſcrying any of this myſterious wiſdom, it being a ſentence of the
Prov. xiv. 6. ſcripture it ſelf, *that a ſcorner ſeeketh wiſdom, and* [*findeth it*] *not*, (the expreſſion is odd in the original, but I muſt not ſtay to deſcant upon it;) as the Sodomites
Gen: xix. 5, 11. could not find the angels, when once they ſought them to proſtitute and defile them.

But beſides profane wits, there are too many other readers, who are (more or leſs) guilty of oppoſing the reforming and improving influence of the ſcripture, upon their own hearts; either upon the ſcore of their not ſufficiently believing the truths contained in the ſcripture, or upon that of their not duly pondering them. That unbelief is the fruitful mother of more ſins than are wont to be imputed to it, and that many baptized perſons are not free from greater degrees of it, than they are ſuſpected of by others, or even by themſelves, I could here eaſily manifeſt, if I had not profeſſedly diſcourſed of that ſubject in another place. And indeed, there needs but a comparing of moſt men's lives with the promiſes and threats held forth in the ſcripture of no leſs than everlaſting joys and endleſs torments, to make us believe, that there are multitudes of profeſſed Chriſtians, to whom may be applied what the writer to the
Heb. iv. 2. Hebrews ſays of the perverſe Jews of old, *That what they heard did not profit them, not being mixed with faith in them that heard it*, or (as the Greek will bear) becauſe they were not united by faith to the things they heard. But this is not all, for oftentimes the doctrines of the ſcripture loſe much of their efficacy, even where they are cordially believed, becauſe they are not ſufficiently laid to heart. The diſparity of the influences of the bare belief and the due perpenſion of a truth is, methinks, conſpicuous enough in men's thoughts of death. For though that they ſhall die is ſo truly believed, that it cannot ſeriouſly be doubted; yet how doth men's inadvertency make them live here, as if they were to do ſo always? Whereas when once grace, ſickneſs, the ſight of a dying friend, or ſome other tragick ſpectacle, hath ſeriouſly minded them of death, it is amazing to obſerve, how ſtrange an alteration is produced in their lives by the active and permanent impreſſion of that one obvious and unqueſtioned truth, that thoſe lives muſt have a period; and to ſee how much the ſober thoughts of death contribute to fit men for it: it being ſo imperious an inducement to deny
Tit. ii. 12. ungodly and worldly luſts, and to live σωφρόνως καὶ δικαίως δὲ εὐσεβῶς ἐν τῷ νῦν αἰῶνι, *ſoberly, righteouſly, and godly in this preſent world*, that we muſt one day leave it; that I admire not much that father's celebrated ſtrictneſs and auſterity, who tells us, that he fancied always ſounding in his inward ears, that dreadful alarm of, *Surgite mortui, & venite ad judicium.*

Yet notwithſtanding the indiſpoſition of many readers to reverence and obey the ſcripture, and notwithſtanding that in divers paſſages of it, the ornaments of language are (for reaſons above ſpecified) purpoſely declined; yet we find not, but that the ſcripture, for all theſe diſadvantages, is by the generality of its readers both eſteemed and obeyed at another-guiſe rate, than any other book of ethicks or devotion. And multitudes even of thoſe, whoſe paſſions, or intereſts, will not ſuffer them to be in ſome points guided by it, are notwithſtanding ſwayed by it, to forbear or practiſe divers things, in caſes wherein other books would not prevail with them. As *Herod*, though the Baptiſt could not perſuade him to quit his *Herodias*, did yet, upon *John*'s
Mark xii. 37. preaching, do many other things, and *heard him gladly*.—I was going to ſay, that we may not unfitly apply to the word of God, what divines have obſerved of God the

word; for as thoſe accidents, that loudlieſt proclaimed our Saviour's having aſſumed our human nature and infirmities, were attended with ſome circumſtances, that conſpicuouſly atteſted his divinity; ſo in thoſe paſſages, in which the majeſty of the author's ſtyle is moſt veiled and diſguiſed, there is yet ſome peculiarity that diſcloſes it. But I ſhall leſs ſcruple to tell you, that in divers of thoſe paſſages, in which the Holy Ghoſt (who in the Greek fathers wonted expreſſion does often συγκαταβαίνειν ἡμῖν, ſtoop to our capacity, and, as it were, ſink himſelf down level) ſeems moſt to have vouchſafed a condeſcenſion to the ſtyle of men; and to have commanded his ſecretaries, as he once did the prophet *Iſaiah*, to write, בחרט אנש *Be-chæaet Enoſh*, *with a man's pen*; in divers of thoſe very places, I ſay, there is ſomething of ſo aweful, and ſo peculiarly his, that as the ſun, even when he deſcends into the Weſt, remains ſtill lucider than any of the ſtars; ſo the divine inſpirer of the ſcriptures, even when his ſtyle ſeems moſt to ſtoop to our capacities, doth yet retain a prerogative above merely human writings. *Known unto God are all his works from the beginning of the world*, ſays an Apoſtle; and God, whoſe attribute is to be καρδιογνώστης, *the knower of hearts*, and whoſe prerogative it is to *form the ſpirit of man within him*, *underſtandeth our thoughts afar off*. Certainly then, if we conſider God as the creator of our ſouls, and ſo likelieſt to know the frame, and ſprings, and nature of his own workmanſhip; we ſhall make but little difficulty to believe, that in the book written for, and addreſſed to men, he hath employed very powerful and appropriated means to work upon them. And in effect, there is a ſtrange movingneſs, and, if the epithet be not too bold, a kind of heavenly magick to be found in ſome paſſages of the ſcripture, which is to be found no where elſe; and will not eaſily be better expreſſed, than in the proper terms of the ſcripture: *For the word of God*, (ſays it) *is quick and powerful, and ſharper than any two-edged ſword, piercing even to the dividing aſunder of ſoul and ſpirit, and of the joints and marrow, and is a diſcerner of the thoughts and intents of the heart*. Wherefore, that *Junius* (as himſelf relates) was converted from a kind of atheiſt to a believer, upon the reading the firſt chapter of *John*; that a Rabbi, by his own confeſſion, was converted from a Jew to a Chriſtian, by the reading of the fifty-third of *Iſaiah*; that St. *Auſtin* was changed from a debauchee into a ſaint, by that paſſage of the 13th to the *Romans* and 13th verſe; and that another father, whoſe fear had made him diſclaim his faith, burſt out publickly into a ſhower of tears, upon the occaſional reading of the 16th verſe of the 50th *Pſalm*; are effects, that I do not ſo much admire, as I do, that ſuch are produced no oftener. And truly for my own part, the reading of the ſcripture hath moved me to more, and ſwayed me more powerfully to all the paſſions it would infuſe, than the wittieſt and eloquenteſt compoſures, that are extant in our own and ſome other languages. Nay, ſo winning is the majeſty of the ſcripture, that many (like thoſe that fall in love in earneſt with the ladies they firſt courted, but out of, what the French call gallantry) who began to read it out of curioſity, have found themſelves engaged to continue that exerciſe out of conſcience: and not a few of thoſe, that did at firſt read the new teſtament only to learn ſome unknown language it is tranſlated into, or for ſome ſuch trivial purpoſe, have been by the means, that they elected, carried beyond the end that they deſigned, and met a deſtiny not ill reſembling that of *Zacheus*; who climbing up into a ſycamore growing in our Saviour's way, only to look upon him, paſſed thence to be his proſelyte and convert, and to entertain him joyfully both in his houſe and heart. And though it be true, that the church's teſtimony be commonly our firſt, yet it is not always our chief inducement to believe the divinity of Holy Writ; its own native prerogatives heightening that into faith, which the church's authority left but opinion. To which purpoſe, I remember a handſome obſervation of ſome of the ancients; that the Samaritans,

Iſa. viii. 1.

Acts xv. 18.

Acts i. 24.
Zech. i. 1.
Pſal. xiii. 2.

Heb. iv. 12.

Luke xix. à ver. 1. ad ver. 10.

Mat. xiii. 19, 20, &c.

that firſt believed in Chriſt upon the woman's report, when afterwards they were bleſſed with an immediate converſation with himſelf, they exultingly told the woman, John iv. 39—42. *now we believe, not becauſe of thy ſaying; for we have heard him our ſelves, and know that this is indeed the Chriſt, the Saviour of the world.* For ſo, divers, that firſt believe the ſcripture but upon the church's ſcore, are afterwards by acquaintedneſs brought to believe the ſcripture upon its own ſcore; that is, by the diſcovery of thoſe intrinſick excellencies and prerogatives that manifeſt its heavenly origination.—This ſacred book, even where it hath not embelliſhments of language, doth not want them; being ſo much recommended by its imperious perſuaſiveneſs without them, that it is more ennobled by their needleſſneſs, than it would be, by their affluence. And if to ſome paſſages of ſcripture we muſt apply that of St. *Paul*, (whereby yet he thought to 1 Cor. ii. 1—4. recommend his miniſtry to the Corinthians) *That his ſpeech and his preaching was not with the enticing words of man's wiſdom, but* ἐν ἀποδείξι πνεύματος καὶ δυνάμεως, we may alſo remember, that he ſubjoins as the reaſon, that moved him to uſe this plain and Ver. 5. unadorned way of teaching his Corinthians, *That their faith might not ſtand in the wiſdom of men, but in the power of God.* And truly the efficacy and operations of the Bible, in compariſon of thoſe of all other books, duly conſidered, we may eſteem, that as God oftentimes doth in the ſcripture, what in the ſcripture he is ſaid to do, draw us with the cords of a man, (paſſages wreathed with flowers of rhetorick) ſo is it not unfit, that we ſhould ſometimes employ expreſſions, that carrying away our obedience, our reverence, and our aſſent in ſpite of our indiſpoſitions to them, might manifeſt their derivation from him, who is not tied to ſuch means, as men would think neceſſary, but can compaſs his ends as well by as without any. Nor can I often conſider the inſtances experience affords us of the efficacy of many texts, (which ſome that pretend to eloquence accuſe of having none) without ſometimes calling to mind, how in the book of nature God has veiled in an obſcure and homely ſtone an attractiveneſs (unvouchſafed to diamonds and rubies) which the ſtubborneſt of metals does obſequiouſly acknowledge. And as the loadſtone not only draws what the ſparklingeſt jewels cannot move, but draws ſtronglier where armed with iron, than crowned with ſilver; ſo the ſcripture not only is movinger than the glitteringeſt human ſtyles, but hath oftentimes a potenter influence on men in thoſe paſſages, that ſeem quite deſtitute of ornaments, than in thoſe, where rhetorick is conſpicuous.

The concluſion of one part of the diſcourſe, concerning the ſcripture; and the tranſition to the next.

I SHOULD now, *Theophilus*, immediately paſs on to the other things I am to diſcourſe to you of, concerning the ſcripture, but that the curioſity, wherewith you are wont to take notice of my practices, and to make inquiries after my private opinions, makes me imagine you telling me, that I do often read, and do much oftener commend books of devotion, notwithſtanding all the prerogatives I have attributed to the ſcripture: wherefore to this I ſhall anſwer, that I eſteem indeed the truths of ſcripture ſo important and valuable, that I cannot be troubled to ſee them preſented to us in variety of dreſſes, that we may the more frequently and the more attentively take notice of them. And though ſome devout compoſures are ſo unſkilfully written, as to be much fitter to expreſs the devotion of the writer, than to excite it in the reader; yet there are others ſo handſomely and ſo pathetically penned, that a good man can ſcarce read them without growing better, and even a bad man muſt be very much ſo, without becoming leſs ſo by peruſing them. Nor do I at all deſign to diſparage books of devotion, when I prefer the ſcripture to them, that being ſo noble and matchleſs a work, that a book may attain to a high degree of excellence, whilſt it remains inferior to the ſcripture, and of whoſe preheminencies I have already on ſeveral occaſions named divers to you; and therefore ſhall at preſent only recommend to your obſervation this one advantage of the ſcripture, even as to thoſe things, that are alſo to be met with in other books of devotion; That if *the words of the wiſe be* Eccleſ. xii. 11. (as *Solomon* tells us they are) *like nails faſtened by the maſters of the aſſemblies*, the ſelfſame nail muſt enter leſs or deeper, according to the ſtrength of the hand that drives it in; and doubtleſs, any doctrine believed to come from God, in the ſame terms it is delivered to us, is like to be entertained with a deeper and obſequiouſer reſpect; concurrently whereunto, the Apoſtle, to ſet forth the Theſſalonians reception of the goſpel, ſays, *That they received it not as the word of men*, but *(as it is in truth) the* 1 Theſſ. ii. 13. *word of God.* After which, it is no wonder he could immediately ſubjoin, that *it did alſo effectually work in them that believed.* And though it be very true, that the foreignneſs and obſcurity of ſome texts will require, as well as the teeming richneſs of others will bear, their being alledged in words much more numerous than thoſe, whoſe involved or contracted ſenſes they are to diſplay; yet is it alſo as true, that men do not unfrequently miſtake themſelves in thinking to deliver the Holy Ghoſt's conceptions in fitter terms than his own, the proper preciſe expreſſions of ſcripture being oftentimes ſo pathetical and ſinewy, that he, that ſtretches them, enervates them; and paraphraſes, though handſome, do as much wrong them, as a mixture of ſilver, though no ignoble metal, does wrong an ingot of gold. And though ſome texts like pearls loſe indeed of their beauty; but operate, and are adminiſtered more ſucceſsfully beaten to powder, or with other cordial ingredients made up into a confection; yet divers ſacred expreſſions do like diamonds loſe both their ſparkling luſtre, and engraving faculty, when ground to duſt, and loſe more in their entireneſs and form than can be recompenſed by any addition. And truly, as to my own particular, no book of devotion doth conſtantly affect me ſo powerfully as the Bible. And whereas I am of ſo nice a palate, that in my eſteem compoſures of that kind ſtill loſe at the ſecond reading; in the inſpired volume, familiarity breeds not contempt, but reverence (and I like a book, acquaintance ſtill endears). When I firſt began attentively to read the ſcripture, and (according to my cuſtom when I read books, whereof I have a promiſing expectation) to mark in the margin the paſſages, that ſeemed to deſerve a peculiar notice or reflection, I marked but here and there ſome verſes in a chapter; but when, upon a greater familiarity with the idiotiſms, the ſenſe, and the applicableneſs of ſcripture, I came to ſurvey it, I then in ſome places marked the whole chapter, and in moſt others left much fewer texts than before unfurniſhed with ſome mark of reference. And whereas at my entrance I took even the choiceſt part of the Bible to be at beſt but like ſome Indian province, wherein though mines and gems were more abundant than in other countries, yet they were but ſparingly to be met here and there: after a competent ſtay, my enſuing peruſals preſented it me, if not as a royal jewel made up of gold and precious ſtones, yet (which is gloriouſer) like *Aaron*'s breaſt-plate, a ſacred jewel, the particular inſtructions for which, were given by God himſelf, and which, beſides the various number of flaming gems ſet in fine gold, and placed in a myſterious order, was ennobled by that *Urim* and *Thummim*, wherein God vouchſafed to reveal himſelf to mortals, and was adorned with ſo much cunning work in gold, blue, purple, ſcarlet, and fine twined linen, that the contrivance and workmanſhip lent a luſtre to the glittering materials, without being obſcured by them. This experiment keeps me from wondering to find in the inſpired poet's deſcription of the man he attributes a bleſſedneſs to, that his *Chaphatz* is in the *law of the Lord, and in his law will* Pſal. i. 2. *he meditate day and night.* For the word other tranſlations render *voluntas & ſtudium*, ours Engliſhes delight; and indeed the Hebrew חפצ will bear both ſenſes, and ſeems there emphatically to ſignify a ſtudy repleniſhed with ſo much delight to the devout and intelligent proſecutors of it, that, like the hallelujahs of the bleſſed, it is at once a duty and a pleaſure, an exerciſe and a recompence of piety. And indeed, if

God's bleſſing upon the devout Chriſtian's ſtudy of that book do (according to the
Pſal. cxix. 8. Pſalmiſt's prayer) *open his eyes to diſcern the* נכלאות *Niplaot, hidden wonders* contained in it; he ſhould, in imitation of him that in the ſame Pſalm ſays of his God,
Verſ. 162. *I rejoice at thy word, as one that findeth great ſpoil*, be as ſatisfied as navigators, that
diſcover unknown countries. And I muſt confeſs, that when ſometimes, with the Apoſtles in the mount, I contemplate *Moſes* and *Elias* talking with Chriſt, I mean the law and prophets ſymphonizing with the goſpel, I cannot but (reſemblingly tranſ-
Mat. xvii. 4. ported with a like motive) exclaim with *Peter*, *it is good for me to be here*; and
Pſal. cxix. 103. ceaſe to think the Pſalmiſt an hyperboliſt, for comparing the tranſcendent ſweetneſs of God's word to that inferior one of honey, which is like it in nothing more, than in that, of both their ſuavities, experience gives much advantageouſer notions than deſcriptions can.

But, *Theophilus*, upon condition you will not call this excurſion of your own occaſioning a fit of devotion, I will no longer detain you on one ſubject, but forthwith proceed to diſcourſe of thoſe other things, that I am to conſider in the ſcripture, beſides the ſtyle. For though this be ſuch as I have been repreſenting it, yet I hope we ſhall in our progreſs find, that it will be far leſs fit to apply to this matchleſs book that of the Heathen poet,

*Materiam ſuperabat opus*——

Pſal. xlv. 13. than that ſacred one of the Pſalmiſt, where he as well ſays, that *the king's daughter is all glorious within*, as that *her cloathing is of wrought gold*.

# OCCASIONAL
# REFLECTIONS
# UPON
# SEVERAL SUBJECTS.

## WHERETO IS PREMISED
## A DISCOURSE about ſuch kind of THOUGHTS.

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*Omnibus rebus, omnibuſque ſermonibus, aliquid ſalutare miſcendum eſt. Cum imus per occulta naturæ, cum divina tractamus, vindicandus eſt à malis ſuis animus, ac ſubinde firmandus.* Sen. Natural. Quæſt. Lib. 2. cap. 59.

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## To *SOPHRONIA**.

My dearest Sister,

YOU receive, in this effect of my obedience, one of the higheſt proofs I can give you of its greatneſs. For when you command but things, that tend to your ſervice, the performance is wont to be accompanied with a ſatisfaction, that ſuffers me not to find it uneaſy. But I confeſs it was not without reluctancy, that I was prevailed with to venture abroad compoſures, wherein, even when I publiſh them, I decline owning them; and which (if our names be diſcovered) may, I fear, not only hazard the reputation (if it have any) of my pen; but (where you are leſs known) bring into queſtion that of your judgment. It was eaſy for me to repreſent to you, how unfiniſhed and unpoliſhed the trifles you called for were; eſpecially conſidering, that the immatureneſs of ſome of them would not probably be the chief thing, that would make many think they come forth unſeaſonably, ſince they avowedly aim at the perſuading and teaching men to improve their thoughts, as well as huſband their time, at a ſeaſon, when both thoſe precious things are ſo neglected, or ſo miſ-employed, that the chief uſe, which too many make of the former, is to deviſe ways to get rid of the latter. But though, to my unreadineſs to publiſh theſe very long neglected papers, at the ſame time when a pre-engagement obliged me to diſpatch another treatiſe of a quite different nature, I added all thoſe other diſſuading conſiderations, that I have mentioned in the preface to the reader; yet what I repreſented proved as unavailable, as what I had written was incompleat. For, whilſt you fancied, that the following reflections (ſuch as they are) had fewer faults, and were like to do more good, than I can preſume; your charity for others, and partiality for me, made you ſo reſolute and preſſing to have me run a venture, which you are pleaſed to think but a very ſmall one, that I judged it more excuſable

* It is the name given to the ſame lady in the 2d ſection of the following meditations.

to preſent you green fruit, than, by obſtinately refuſing what you ſeemed almoſt to long for, loſe an opportunity of evincing, that your commands can prevail, both where thoſe of others would have been wholly ineffectual, and when they required me to preſent you (ſome, if not many) things, that are ſo little worthy of you, that perhaps they are ſcarcely ſo, even of me.

WONDER not, dear *Sophronia*, that I appear ſo ſollicitous to manifeſt the greatneſs of my obedience; ſince that implies an urgency in your commands, that it highly concerns me to have taken notice of. For thoſe, that, having the happineſs to converſe with you, ſhall chance to caſt their eyes upon the following papers, will probably think, that I ſhew as little diſcretion in the addreſs, as I have ſhewn ſkill in the writing, of theſe reflections; when I expoſe ſuch cenſurable things to the judgment of a perſon, that has ſo piercing a one, and preſent trifles to one, that deſerves the nobleſt productions of (what ſhe is ſo great a miſtreſs of) wit, and eloquence. Upon whoſe account ſhe is wont to perſuade piety as handſomely in her diſcourſes, as ſhe expreſſes it exemplarily in her actions; and might, if her modeſty did leſs confine her pen to excellent letters, both make the wits of our ſex envy a writer of hers, and keep our age from envying antiquity for thoſe celebrated ladies, who, by their triumphant eloquence, ennobled the people of *Rome*, and taught their children to ſway thoſe rulers of the world.

BUT when I can plead, that not only your commands, but even your importunity ingaged me (though not to the addreſs, yet) to the publication of theſe papers; I may reaſonably hope, that among thoſe many conſiderable perſons, to whom your attainments are not unknown, not only my dedication will be excuſed, but even my book will not be ſo haſtily condemned.

BUT I dare not proſecute ſo fruitful a ſubject, for fear of offending your modeſty; ſince that predominant virtue gives you ſo great an undervaluation for all your other qualities, that it is as much your cuſtom to look even upon ſmall praiſes as flatteries, as it is your prerogative to keep great ones from being ſo. And I ſhould therefore have omitted that little itſelf, which I have ſaid, if, on this occaſion, my intereſt did not as well oblige me, as the known truth warrant me, ſo to conſider your modeſty, as not to be altogether injurious to your other excellencies; ſince the reader's knowledge of theſe (if he be not a ſtranger to you) will promiſe me this advantage, that divers of the criticks themſelves will chuſe rather to abſolve my writings, than condemn your judgment; and that at leaſt the devout, to whom your practice has afforded ſo many other examples, will be ſcrupulous to be more ſevere to theſe papers, than a perſon, in whom, upon the ſcore of her own ſtyle, ſeverity were more juſtifiable than in moſt readers, (without excepting the eloquent ones) and will imitate her, in conſidering, that this book pretends to preſent them thoughts, rather than words; and in ſupporting, for the ſake of the deſign, the manner, in which it is proſecuted.

AND certainly, my lady *R*'s approbation is a happineſs, which divers ſorts of conſiderations may render as advantageous as welcome to me. For if any of theſe thoughts do (which yet I can ſcarce hope) derive it from your juſtice, that great meaſure of eſteem you do not only merit, but poſſeſs, may both aſſure them of a general one, and much contribute to procure it them. But if all of them owe your approbation (as I fear they do) to your partiality; ſince that muſt not be ſmall, to be able to pervert ſuch a judgment, this it ſelf will prove an evidence of the bleſſing of your affection; which is a felicity, that I know you enough to value above all the praiſes I can miſs of: ſince applauſe can make me happy but in other men's opinion, but your friendſhip can make me ſo in my own. Yet, apprehend not, ſiſter, that I ſhould here endeavour, by a ſolemn character of you, to juſtify what I have been ſaying; for, though to write a dedicatory epiſtle, without a panegyrick, be grown of late very unfaſhionable; yet ſince it is as much ſo, to take the praiſes wont to be profuſely given in ſuch letters for meaſures of any thing but the writer's wit, I muſt rather reſerve the acknowledgments I owe your merit and your favours, to ſome occaſion, where they may not be liable to paſs for a tribute paid to cuſtom, not a debt due to you, than draw a needleſs ſuſpicion upon the ſincerity of our friendſhip, by endeavouring to expreſs my affection and eſteem in a dedicatory letter; and by chuſing to profeſs, upon an occaſion where cuſtom allows men to ſay what they do not think, ſo great and real a truth, as that of my being, far more upon the account of eſteem and gratitude, than of nature it ſelf,

My deareſt Siſter,
Your moſt affectionate,
and moſt faithful Servant,

*R. B.*

## An Introductory Preface.

WHEN I conſider the diſadvantages with which the following trifles come abroad, in an age, that is not only ſo cenſorious, but ſo intelligent, as this of ours; neither the partiality of my friends, nor the favourable reception, that the publick has hitherto vouchſafed to what hath been preſented it of mine, is able to give me a confidence, (though they almoſt create a hope) that theſe papers will meet with as kind an entertainment, as thoſe of the ſame hand, that have preceded them. And yet, without being wanting to my ſelf, I cannot but add, that by the help of their ſuggeſtions, who have urged the publication of theſe thoughts, I am not unfurniſhed with (at leaſt) tolerable excuſes for the things, that ſeem likely to ſtand in need of any.

I SHALL not much wonder to find it ſaid, that the book is, in general, far ſhort of being an exact and finiſhed piece. For perhaps few readers will be more of that mind, than the author is. But by way of apology, it may be repreſented, that moſt of the following papers being written for my own private amuſement, a good deal of negligence in them may appear as pardonable, as a careleſs dreſs, when a man intends not, nor expects, to go out of his ſtudy, or let himſelf be ſeen. And that which I now publiſh, being deſigned, not to ſatisfy the criticks, but to gratify the devout, I hope it will be thought a venial crime, if in ſome of theſe meditations I have not aimed to expreſs eloquence, but only to cheriſh piety. I ſay in ſome, becauſe there may be others (where a different ſtyle was thought fitter) in whoſe favour I would produce ſuch ſuffrages, as would not be ſlighted, if I were concerned to do any more for thoſe papers, than excuſe them.

AND perhaps they, that ſhall take the pains to try their ſkill in making meditations indifferently upon the occurrences that ſhall happen, and wander no farther from the circumſtances of their themes, nor lard them any more with ſentences and other paſſages borrowed from the fathers, or the poets, than in moſt of the following papers I have done; will not find the taſk ſo eaſy, but that they will think it reaſonable

able to be mild in their cenſures, and will diſcern, that in ſuch compoſures, ſome unaccurateneſs is ſo hard to be avoided, that it ſhould not be hard to be forgiven.

I KNOW the want of uniformity in the ſtyle of the enſuing reflections may ſpeciouſly enough be cenſured. For, not to mention, that ſome of them are very long, and others very ſhort; it will be ſaid, that ſome are written in a very neglected, and others even in a luxuriant ſtrain; and there may (perchance) appear betwixt ſome of them as great an inequality as can eaſily be found betwixt compoſures, that are none of them excellent. Beſides that the incoherence of the ſubjects, together with the differing ways wherein they are handled, may make them look ſo little of kin to one another, as ſcarce to appear the productions of the ſame pen. But this uneven way of writing will poſſibly be rather pardoned than wondered at, by thoſe, that ſhall be informed,

THAT the nature of this kind of compoſures requires not any other, than a looſe and deſultory way of writing.

THAT theſe reflections are very far from coming abroad in the order of time, wherein they were ſet down; but in that caſual order, wherein, when I was engaged to tack them together, I was able to light on them among my looſe and forgotten papers. Many of which being diſcovered to have been loſt, when ſome of the reſt were to be at the preſs; I was fain, for the compleating of the number, to inſert here and there ſome of a much freſher date, among thoſe that were made (as ſome know, who then read them) ſixteen or ſeventeen years ago, when my ſtyle could hardly be other than differing enough from what it now is.

AND laſtly, that the differing natures of ſeveral ſubjects required, that the reflections on ſome of them ſhould be far longer than others. And as my want of leiſure, and ſometimes of diſpoſedneſs to write, induced me to make ſome of my conſiderations but ſhort; ſo I thought fit to let them paſs for their ſakes, to whom, for want of time or ſkill, the brevity of thoſe may make them the fitter, and the more recommend them.

BESIDES what has been alledged againſt the ſtyle, I know it may be objected, that in ſome of the meditations the ſubjects are very mean, and trivial; and that ſuch themes are not worthy the being deſcanted on. And indeed, if I aimed at the writer's advantage, more than the reader's, I could eaſily have left them out, and have ſubſtituted in their places, ſome others, that lie by me, leſs liable to contempt. But I confeſs, I did not think my ſelf obliged to publiſh no meditations, but the leaſt cenſurable ones that I had made; and divers of thoſe intimated in the objection were purpoſely inſerted, when I was prevailed with to bundle up theſe looſe ſticks into faggots. For then, deſigning this treatiſe for the benefit of the generality of devout readers, I thought it not amiſs, amongſt divers reflections, (ſuch as moſt of the ſecond, and of the fourth ſections) more ſuited to thoſe peruſers that are either of the more intelligent ſort, or good proficients already, to inſert ſome few meditations, of a more familiar ſort, and eaſier to be lighted on; to keep thoſe from being diſcouraged from trying to make occaſional reflections, who may chance to have either barrenner fancies, or more unpractiſed pens, than even I had then. And thoſe (perhaps) who, without ſuch eaſily imitable examples, would not be invited to make occaſional meditations, may, by the practice of compoſing them, grow ſuch proficients in the art, as to ſurpaſs ſome, that deſpiſe ſuch humble beginnings.

BUT as I ſend abroad theſe papers without the author's name, that I may have the greater opportunity to hear other men's opinions of them, and the leſs temptation to wave the complying with thoſe that ſhall ſeem reaſonable; ſo if I ſhall find, that ſuch readers, as I eſteem competent judges in an affair of this nature, ſhall think, that thoſe reflections, wherein I have complied with the weaker ſort of peruſers, may be better ſpared, than inſerted; I can eaſily repair that fault in the next edition (if theſe trifles ſhall be thought worthy of another). In the mean time, I preſume, that thoſe devout readers, who may be concerned in this matter, will take it kindly, that I have, for their ſakes, adventured to treat of ſubjects too mean and barren to furniſh me with almoſt any thing conſiderable, ſave the opportunities of manifeſting, how low I can ſtoop to gratify ſuch perſons.

I KNOW it is a new thing, that I have ventured to put ſome occaſional reflections into dialogues. But the reader will be leſs ſtartled at my deviating in this, and other things, from biſhop *Hall*'s way of writing occaſional meditations, if I acknowledge, that not to prepoſſeſs or biaſs my fancy, I purpoſely (till of late) forbad my ſelf the peruſing of that eloquent prelate's devout reflections. Which intimation being premiſed, I ſhall ſubjoin, that when I wrote for my own divertiſement, I ſometimes took pleaſure to imagine two or three of my friends to be preſent with me at the occaſion, that ſet my thoughts on work, and to make them diſcourſe, as I fancied perſons, of their breeding and tempers, would talk to one another on ſuch an occaſion. And one of theſe, whom I call *Euſebius*, being a Doctor of divinity; two others (*Eugenius* and *Genorio*) being travellers and fine gentlemen; and the fourth, (whom I name *Lindamor*) being a learned youth, both well born and well bred; I was apt to think, that ſome of their conferences might be allowed to paſs among the other papers; both becauſe novelty, and variety, are wont to be not unwelcome things, and becauſe this way of writing allows a ſcope for diverſity of opinions, for debates, and for replies, which moſt commonly would be improper, where only a ſingle ſpeaker is introduced. Not to add, that poſſibly if this way of writing ſhall be liked and practiſed by ſome famed and happier pen, that were able to credit and improve it; it may afford uſeful patterns of an inſtructive and not unpleaſant converſation: and ſuch reflections, being of the nature of ſhort and occaſional eſſays, may afford men the opportunities of ſaying the handſomeſt things they know, on ſeveral ſubjects, without ſaying any thing elſe of them, or filling above a ſheet, or perhaps a ſide of paper at a time. And the liberty, that this way of introducing ſpeakers allows, brings with it a conveniency, which it is more eaſy for an intelligent reader to conjecture at, than it were diſcreet for the writer to mention expreſly.

ANOTHER novelty will probably be taken notice of in the following papers, where the ſecond and fourth ſections, though by far the longeſt in the whole book, are intirely taken up; the former only by meditations on accidents relating to an ague that once afflicted me; and the latter by thoſe, that occurred to ſome anglers by the river ſide. But for this matter, I preſume, it will not be difficult to apologize. For having obſerved men to be inclinable, either openly to object, or at leaſt tacitly to ſuſpect, that in occaſional meditations, that may hold true, which is (perchance not altogether undeſervedly) ſaid of epigrams, that in moſt of them the conceits were not ſuggeſted by the ſubjects, but ſubjects were pretended, to which the conceits might be accommodated; I thought, that to manifeſt, that (at leaſt, ſome) writers of this kind of compoſures need not have recourſe to the ſuſpected artifice, the fitteſt way I could take was, by putting together, what the accidents of my ague, and of my angling journey, had ſuggeſted to me, to ſhew, that it is very poſſible for a perſon, that pretends not to a very pregnant fancy, to diſcourſe by way of reflection upon the ſeveral circumſtances, that ſhall happen to occur to his conſideration, though one ſubject ſhould require above fifteen differing meditations, and the other above twenty. Not to add, that it was rather wearineſs and deſign, than want of thoughts upon other paſſages relating to the ſame ſubjects, that kept me from increaſing the number of thoſe reflections.

As for the ſimilitudes, though ſome would make me hope, that they will be at leaſt excuſed; and though it were perhaps no great vanity for one, that does aſſiduouſly enough converſe with the works of nature and the productions of art, to think he has the means of furniſhing himſelf with pretty ſtore and variety of compariſons: yet for all this, I am not willing to quit my pretenſions to a ſhare in the wonted effects of that common equity, which forbids to exact too accurate a likeneſs in the making of compariſons, which orators confeſs ought to be judged with indulgence, and without exacting a conformity in other attributes betwixt the things compared, provided there be a competent likeneſs in reference to the particular, wherein the collation or parallel is made.

And if I have, on ſome occaſions, proſecuted the reſemblance through all the particularities, wherein the parallel could be made to hold, more fully and nicely than is uſual in ordinary compariſons; and if in ſo doing I may have at any time a little ſtrained the ſimilitude, the better to accommodate it to my preſent theme, and deſign; I have this to repreſent, that to diſplay reſemblances to the full, and inſiſt on their particular circumſtances, is oftentimes no more than the nature of theſe compoſures does allow, if not require; and that, on ſuch occaſions, to ſtretch the parallel as far as it can well be made to reach, is but a venial fault, which many readers are diſpoſed not only to pardon, but to like. As if, in ſome caſes, it fared with ſimilitudes as with bows, which they though they may be bent ſo forcibly, as to be thereby broken or ſpoiled; yet by being ſtrained ſomewhat more than ordinarily, they acquire a greater ſtrength, and enable the arrow to pierce farther, and to make a ſmarter impreſſion, than elſe it would.

The protaſis (as rhetoricians call the firſt part of a compariſon) may in ſome of the following reflections appear to be too much amplified, and needleſly to lengthen the meditation. But not to urge, that ſometimes the more conſpicuous adjuncts of the ſubject were ſo mean and barren, that there was a kind of neceſſity to exaggerate, or to expatiate upon little circumſtances to invite attention; the protaſis, wherein we diſplay and conſider the minute particularities of the theme, being the ground-work of all the reſt, and it being far more eaſy to ſay little, than much, with equal pertinency upon a ſubject; I thought it not amiſs, to afford unpractiſed readers the moſt aſſiſtance of examples in ſuch caſes, wherein it is probable they will moſt need it; eſpecially ſince he, that has accuſtomed himſelf to write copiouſly, may eaſily contract his diſcourſe when he will, by omitting as many paſſages as he pleaſes; and it is far more difficult for a beginner to ſupply barrenneſs, than retrench ſuperfluities. Which are not always ſuch faults, but that I remember ſome great maſters in the art of oratory have pronounced redundancy to be a good ſign in a young writer, as taking it for a mark of a fruitful and exuberant fancy, that, in its productions, there is ſomething to be cut off. So that if there ſhould be found any luxuriant expreſſions in ſome of thoſe thoughts, that were written down, when I had not yet attained my 19th or 20th year, when I might be allowed to write not always to employ, but ſometimes to amuſe my ſelf; I may hope, that the ſame youth, that was my temptation to write them, may prove my excuſe for having written them, as it may for leaving them unexpunged; that as I deſire to invite as well young gentlemen as other readers, to pen occaſional meditations, ſo I find, that ſome of the readers, I am willing to pleaſure, do as little diſlike that luxuriant way of writing now, as I did then: as youths and ladies oftentimes better reliſh muſt than wine.

I know too, that there may be found, in ſome of thoſe protaſes, divers paſſages, and particularly ſome deſcriptions (that often make a great part of them) which to ſome readers will not ſeem noble and gaudy enough. But to ſuch peruſers it may be repreſented, that a ſuitableneſs to the theme, how mean ſoever it be, may very well, as a piece of decorum, be allowed to a writer, and in few caſes more than in point of deſcriptions: and that theſe being but pictures drawn (with words inſtead of colours) for the imagination, the ſkilful will approve thoſe moſt, that produce in the mind, not the fineſt ideas, but the likeſt; as a critick in limning will more prize the picture of an old meagre Sibyl, where the wrinkles and the ſallow ſkin are drawn exactly to the life, than a dozen ordinary pictures of the ſpring, (which yet are wont to charm vulgar eyes) though the youthful face, which repreſents that florid ſeaſon, have as gaudy colours upon the cheeks and lips, as imbelliſh the roſes and lilies, which compoſe the chaplet that adorns the head.

And poſſibly there will be found other readers (and thoſe too ſkilled in rhetorick) that will accuſe ſome other of our meditations, as being too elaborate, or too pompous, for the themes, whereunto they are accommodated. But having laid by a competent number of thoſe lately mentioned reflections, wherein I aimed chiefly at inviting and aſſiſting readers of meaner capacity; I confeſs, that in the other meditations, aiming either at my own divertiſement, or the gratifying another ſort of perſons, I allowed my ſelf to make choice of ſuch applications of the objects I conſidered, as I thought every body would not ſo eaſily light on. And, provided the reflections were not ſtrained, nor too far fetched, I thought it not amiſs they ſhould be ſomewhat ſurpriſing; that I might by the way of handling the ſubjects I was to treat of, ingage an attention, which otherwiſe I could ſcarce expect for ſuch unpromiſing themes. I know, that if the judgment of ſome ſevere criticks were as infallible as themſelves think it, the ſtyle of ſome of the following reflections would ſeem diſproportionate to ſuch mean and trifling ſubjects. I do not perhaps ignore what rhetoricians are wont to teach, of what they call the three differing characters of writing; I have read thoſe diſcourſes, that *Cornificius* propoſes as the patterns of the ſublime, the moderate, and the humble way of expreſſing one's ſelf on differing occaſions; and I have been taught, and willingly acknowledge, that all themes are not ſo well capable of that character, which they call ſublime; and that, according to the nature and dignity of the ſubjects that one treats of, the manner of handling them ought to be varied. But if I were much concerned in this matter, I might reply, that notwithſtanding all this, I know, that even the artiſts themſelves do not ſo perfectly agree about the defining of theſe matters; and the grand rule about theſe characters being only, that the laws of decorum (or, as the French call it, *bien-ſeance)* be not violated, in the eſtimate of that decorum, I ſee no great reaſon to confine my ſelf to the magiſterial dictates of either ancient or ſcholaſtick writers. For, living in this age, and in this part of the world, where we are not like to have thoſe for readers, that died before we were born, I ſee not why one may not judge of decorum by the examples and practices of thoſe authors of our own times and countries, whoſe writings are generally eſteemed by judicious men.

And certainly, in the judging of what is decent on particular occaſions, we muſt as well conſider, who it is that is introduced as the ſpeaker, as what it is he ſpeaks of. And though it be improper to do what thoſe have done, that have unadviſedly made ſhepherds and nymphs diſcourſe like philoſophers or doctors of divinity; yet when the writer either ſpeaks himſelf, or introduces any, whom he repreſents as intelligent perſons; they may be allowed, even about things ordinary and mean, to talk like themſelves, and employ expreſſions that are neither mean, nor ordinary.

It nigrum campis agmen.

As *Virgil*, in his admired Georgicks, does in ſome paſſages, where he treats of contemptible inſects, ſpeak of them in ſo noble and lofty a ſtrain, that when he mentions multitudes of ants, one would think he were ſpeaking of an army of Moors; and when he gives an account of bees, his expreſſions about their common-wealth would ſcarce miſbecome the majeſty of that of *Rome*. Such paſſages do, notwithſtanding the great diſparity of themes, make the ſtyle of his Georgicks as well noble (if not ſtrictly heroick) as that of his Æneids; and when he writes of ants and flies, he does it in a ſtrain worthy of the ſame pen, that ſo loftily deſcribes the deſtruction of *Troy*, and the adventures of that hero, whom he would have to be (thought not immediately) the founder of *Rome*.

I WILL not ſay, that ſince there is a mode in language as well as in clothes, I ſee not, why the faſhion, that now-a-days allows our gallants to wear fine laces upon canvaſs and buckram, might not warrant the tricking up of ſlight ſubjects, with the richer ornaments of language: nor will I examine, whether men may not except againſt the authority of ſome jejune writers, that taking upon them to preſcribe the laws of ſtyle, make ſo many of their precepts negative, that one may ſuſpect them indited not ſo much by ſkill, as envy; which makes ſuch aſſuming law-givers miſtake the impotence of a barren fancy for the ſkilfulneſs of a critical judgment, and (valuing only the ideas they think they can reach) condemn whatever they deſpair to imitate. And, from thoſe, that would be thought to cenſure the moderns, but out of a veneration for the ancients, one might, methinks, reaſonably expect but light cenſures for employing upon occaſion that noble figure of rhetorick called hyperbole; ſince I ſhould be loth to uſe it often, with no more reſerve, than thoſe great orators, *Tully* and *Iſocrates*, have ſometimes done before me. But a juſt debate of the rules of eſtimating the decency would take up ſo much room, as muſt make it improper for this place; where all I contend for is, that though when one treats of various ſubjects, ſomewhat differing ſtyles are indeed to be accommodated to them; yet this to be ſo done, as ſtill to preſerve a certain dignity in expreſſions. So that a writer may be ſometimes engaged by his ſubject to uſe a lofty ſtyle, but without ever being obliged to employ an abject one; though indeed in ſome caſes he may be allowed to ſtoop below what he is bound to, and forbear ſoaring, as well as avoid creeping. Nor am I, for my own part, much concerned to inſiſt here on the ſubject I juſt now declined to debate. For if I miſ-remember not, *Cicero* himſelf, as well as ſome ſucceeding orators, allow in divers caſes to ſhift characters, even in the ſame diſcourſe, according to the differing particulars, that happen to fall under conſideration; and ſome of them add this reaſon, that hence there will ariſe variety, which is wont to be a welcome thing. And to apply this to the occaſional reflections, that may be concerned in this debate, I muſt deſire the reader to take notice of theſe two things: the one, that tho' the thing it ſelf, which ſets a man's thoughts at work, may be but mean in other regards, yet that, which the reflector pitches upon to conſider, may be of another nature; as though the glow-worm, which afforded me the IVth reflection of the Vth ſection, be but a ſmall and contemptible inſect, yet the light, which ſhines in his tail, and which makes the chief theme of the meditation, is a noble and heavenly quality, and might have juſtified the having many things ſaid of it, for which the ſublime character would have been the moſt proper. The other particular I meant to point at, is, that oftentimes, when the protaſis, or former part of a reflection, is ſpent upon conſidering ſome mean and trivial ſubject, the apodoſis, or reddition, contains ſuch an application of what one was taking notice of in the ſubject, that the thing pointed at may be ſome important moral inſtruction, or perhaps ſome theological myſtery; and conſequently may require and juſtify another than the former humble ſtyle, and admit all the quickneſs of expreſſion and the richeſt ornaments, that belong to thoſe two higher characters, which rhetoricians call the ſubtil, and the magnificent. But if I ſhould now and then deviate from bounds, which, not being conſpicuous, it is difficult never to ſwerve from, I have this peculiar apology to make for ſuch aberrations; that writing for the moſt part of themes wholly new, and untreated of by others, I muſt needs want the aſſiſtance of examples to regulate or authorize my expreſſions; about which I need not be yet very ſollicitous, if I may truſt a learned and applauded writer (whoſe cenſure I deſired) that is both able to judge ſkilfully, and wont to judge freely.

THESE things I have the more carefully inſiſted on, becauſe I would not have thoſe ingenious perſons, that may chance to caſt their eyes on theſe papers, to be tempted by any imperfections of mine, to think otherwiſe of occaſional meditations, than that though there be ſome, yet there are not very many, of their themes ſo low and contemptible, but they are capable of affording reflections of another nature to them, that are dextrous in making application of things. And I would not have ſuch diſcouraged from hoping to find in many themes, that ſeem deſpicable at firſt ſight, ſome hint or other, that may give thoſe, that have wit or eloquence, opportunity enough to diſplay thoſe qualities. For as there is a great difference betwixt ſuch writers, and common ones; ſo it is very material by what pens the ſubject is treated of; and extraordinary perſons, in eſtimating what they are like to perform, muſt not only conſider the unpromiſing nature of their ſubject, but the activity of their own fancy, and the pregnancy of their own wit. For though the ſtars cannot, the luminaries can, clothe the light and wandering vapours of the air with the colour of gold, and of roſes; and the ſun, by his piercing and improving beams, cannot only make diamonds ſparkle, and rubies flame, but by his action upon an obſcure cloud can make even that exhibit all thoſe glorious and charming colours, for which we admire the rainbow.

AND, that the following papers may prove to ſuch perſons the leſſer temptations to undervalue and miſ-judge of this kind of compoſures; I am firſt to advertiſe the reader, that they are capable of ſo much greater variety, than the following treatiſe preſents, that beſides the vaſt multitudes of particulars unmentioned in it, that may be added under thoſe heads, to which the enſuing meditations are referred, there are ſeveral diſtinct ſorts or kinds of occaſional thoughts, (ſuch as thoſe, that are made upon texts of ſcripture, or relate to leſs familiar points of divinity, or other learning, or contain hiſtorical applications, *&c.*) upon which I have, out of haſte, and other reaſons, purpoſely forborn (though not to write, yet) to publiſh reflections. And in the next place, I muſt here frankly acknowledge, that many of the enſuing reflections are ſo far from being the beſt, that even no better a pen than mine could make, that they are much inferior to divers, that I have already made; though (for allowable conſiderations) I have forborn to publiſh them. And I muſt confeſs, that I am more beholden to my occaſional reflections, than they are to me. For, whereas they have furniſhed me with divers of the thoughts, which have been the favourableſt entertained by the readers of my other books of devotion; I did much impoveriſh theſe papers, that profeſſedly contain my occaſional reflections, by not only leaving, but taking out of them ſeveral things, which were the moſt likely to have recommended them; that I might accommodate other writings, for which I had a greater kindneſs or concern.

As for the *Diſcourſe of Occaſional Reflections*, all that I ſhall ſay of it, is, that conſidering how early I attempted that ſubject, and that I was fain to repair, as well as I could, the unſeaſonable miſs of divers papers belonging to it, when I diſpatched it to

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the preſs; conſidering theſe things (I ſay) I deſpair not, but that it will be thought, that I have not ſaid nothing in favour of a ſubject that hitherto had ſo little ſaid to recommend it, that even the eloquent Biſhop *Hall**, employing but ſome lines, not pages, upon the praiſe and utility of it, (which he mentions but in very general terms) left me to find out, by my own thoughts and experience, the various conſiderations, by which I have endeavoured to diſplay the uſefulneſs of the way of thinking I would invite to. Which I have further manifeſted, by applying to that ſcope divers paſſages of ſcripture, (which the reader muſt therefore not wonder, if he do not now meet with) as texts, that either by way of example, or upon other accounts, belong to what I have written about the method of making occaſional reflections.

It is true, the diſcourſe may ſeem ſomewhat incompleat, becauſe of the omiſſion of this way, that is more than once mentioned in it.

But though the looſe papers, wherein that method, and divers examples of it, are ſet down, were lying by me, when I tacked up thoſe that now come abroad; yet my occaſions eaſily prevailed with me to continue to ſuppreſs them. For though I did not much ſcruple to comply with my haſte, and avocations, by forbearing to ſwell a book, whoſe bulk already much exceeded my intention; becauſe that, as the papers, that now appear, were extorted from me, ſo I confeſs, that I was not fond of expoſing thoſe, that I had an expedient to keep back: but that I think it very fit to obſerve, firſt, whether the reception, that the following meditations will find, will make me and others think it worth while to have the ways publiſhed, that I was wont to uſe in making them.

I had almoſt forgot to intimate, that ſome urgent avocations having obliged me to ſend the following treatiſe to the preſs without reading it over my ſelf, I now find, that my haſte will make me need an apology to thoſe readers, that expect to have the paſſages and phraſes of ſcripture printed in a diſcriminating letter, and quoted in the margin. For though in books of poſitive, or of controverſial divinity, I confeſs I have often obſerved a margin, ſtuffed with a multitude of citations, to contain divers ſo unconcluding, if not impertinent, that the number does better ſhew the author's memory than his judgment; yet in books of devotion, I am not much averſe from complying with the generality of readers, who expect to be informed by the margin, where they may find thoſe ſtories and expreſſions, which their being borrowed from an inſpired book, make more operative and emphatical. But I muſt on this occaſion further intimate, that as to thoſe citations of paſſages of ſcripture, wherein I may ſeem to have miſ-recited the words of the text; though as to ſome of them, that were ſet down when I had not a Bible or concordance at hand, my memory may have deceived me as to the words (which is no more than has often happened to the fathers themſelves in the like caſe, and is a venial fault, where dogmatical or polemical divinity are not concerned) yet oftentimes my variations from the Engliſh verſion were made on purpoſe. For having had the curioſity to get my ſelf inſtructed, as well by Jews as Chriſtians, in the eaſtern tongues, (eſpecially in the Hebrew) I thought I need not ſtrictly confine my ſelf to the words of our tranſlators, whenever I could render the meaning of a text in ſuch terms as to me ſeemed proper or expreſſive; or, without injuring the ſenſe of the Hebrew or the Greek, could better accommodate my preſent purpoſe.

Now whereas ſome may think, that in this preface I employ excuſes, that ſeem (ſome of them) not to agree with one another; I deſire it may be conſidered, that the meditations they relate to, being not only written upon differing ſubjects, but (which is more) deſigned for very differing uſes (ſome of thoſe diſcourſes being intended to invite the more unſkilful, and encourage the more deſpondent ſort of readers, and others, to entertain proficients) it was but requiſite, that I ſhould, by every differing (and, perchance, ſeemingly repugnant) conſiderations, give an account of ſuch differing ways of writing them, as ſuch diſtant ſubjects, and my ſcope, required.

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* In the latter part of his proëme, whereof the whole amounts not to one page of this preface.

But what if it ſhould fare with me now, as it has done on other occaſions, on which my friends have accuſed me, of framing more objections againſt my ſelf, than were afterwards made againſt me by my readers? I dare not ſay it is impoſſible, but that this may prove the caſe. But if it do ſo, I ſhall not yet think my ſelf to have altogether miſſed my aim in what I have hitherto repreſented. For I have mentioned the more particulars, and diſcourſed the more largely of them, that if they prove not needful apologies for my reflections, they may prove uſeful conſiderations for thoſe, whom I would invite to exerciſe their pens in ſome ſuch way of writing; divers of whom will probably be encouraged to venture upon making ſuch compoſures, when they find excuſes for divers of thoſe things, that are the moſt likely to be thought to blemiſh ſuch eſſays, (or diſhearten beginners from attempting them) to be drawn up already to their hands. But as for my own particular, if I could make none of the apologies now inſiſted on for the imperfections imputable to this treatiſe; yet I ſhould not be deſtitute of a very juſt excuſe for the publication of it. For divers devout perſons, that had more partiality for theſe writings, and leſs tenderneſs of my reputation, than I could have wiſhed, having long ſollicited the publication of thoſe they had in their hands, were at length ſo reſolved to effect it, that, in ſpite of the promiſes I at length made them to comply with their deſires, when ſome other writings I was then about ſhould be diſpatched; I was fain to make uſe of a legal artifice, to hinder for a while at the Stationers hall the publication of divers papers, that I had not ſo much as read over.

But I confeſs I take notice of theſe paſſages, rather to excuſe thoſe imperfections, which haſte may have occaſioned in theſe immature productions, than to apologize for writing on ſuch a ſubject. For ſo many advantages, that may accrue to a devout and ſkilful perſon, by aſſiduouſly making of occaſional meditations, have been diſplayed in the diſcourſe, that is premiſed to thoſe that follow; that I hope the former part of this book will ſufficiently apologize for my having written the latter; eſpecially if to the other particulars propoſed in the newly named diſcourſe, as things fit to recommend that kind of thoughts, I here be allowed to add, that a man's devotion may not alone be cheriſhed by occaſional meditations, upon the account of thoſe, which every private Chriſtian makes for himſelf, but by the help alſo of thoſe, which he finds made by others, or intends for them. For not only whilſt pious reflections are making, they are proper to inſtruct the mind, and warm the affections; but the objects, upon which ſuch meditations have been made already, either by our ſelves or others, do revive the memory of thoſe good thoughts that were ſuggeſted by them. So that when diligence and proficiency in the practice of our Meleteticks ſhall have ſupplied us with religious, and handſome reflections, upon the moſt obvious works of nature, and the moſt familiar occurrences of human life, devout perſons will have the advantage to live almoſt ſurrounded either with inſtructors, or remembrancers. And when they want ſkill, or are indiſpoſed to extract ſpiritual things out of earthly ones, they may, without racking their invention, be furniſhed with good thoughts, upon many objects, by their memory. For (as I elſewhere more fully declare) thoſe truths and notions, that are dreſſed up in apt ſimilitudes, pertinently applied, are wont to make durable impreſſions on that faculty; inſomuch that though I am far from pretending

Would we but keep our wholeſome notions together, mankind would be too rich. Bp. Hall in his Proëme.

any of the reflections to be met with in the following treatiſe, to be made of that nature; yet ſuch as they are, divers conſiderable perſons of differing ages and ſexes have been pleaſed to ſay (which is an advantage may richly recompenſe more trouble than thoſe writings coſt me) that they ſcarce ever ſee ſuch or ſuch particular things, on which I have written reflections, without remembering both thoſe thoughts, and their author. So that they, who have ſo eaſily attainable things, as happier pens than mine, in ſetting down occaſional meditations, may have the ſatisfaction of making almoſt the whole world a great *Conclave Mnemonicum* *, and a well furniſhed *Promptuary*, for the ſervice of piety and virtue, and may almoſt under every creature and occurrence lay an ambuſcade againſt ſin and idleneſs.

NOR is this indirect way of inſtructing men, unlawful for a Chriſtian, or unworthy of him. For in the ſpiritual warfare, where our adverſary is the old ſerpent, ſtratagems are as lawful as expedient; and he that gets the victory, whether or no he wins reputation by the manner, is ſure to obtain (a greater recompenſe) glory, by the ſucceſs. A teacher is not obliged to imitate *Alexander*, who, upon a diſputable punctilio of gallantry, that was neither wiſe nor charitable, refuſed to ſteal a victory. For the prophet *Nathan* ſcrupled not to deceive *David*, that he might reclaim him, and ſurprize him into a confeſſion of the criminouſneſs of his fault. And the Apoſtles being termed by their maſter, *fiſhers of men*, were warranted to make uſe of baits, as well as hooks and nets. And our Saviour himſelf, by the parable of the wicked huſbandman, that uſurped the vine, drew the Phariſees to an acknowledgment, which they ſtarted from as ſoon as they perceived what they had done. And the ſame divine teacher did ſo frequently imploy fictions to teach truths, that to condemn figurative and indirect ways of conveying even ſerious and ſacred matters, is to forget, how often Chriſt himſelf made uſe of parables. And I am the leſs troubled to ſee ſome thoughts of mine, which, though unpoliſhed, have a natural tendency to inveigle men (if I may ſo ſpeak) into piety and virtue, thruſt abroad into the world; not only becauſe I ſee no reaſon to deſpair, that even as to the moſt obnoxious of theſe meditations, the examples they afford may make them uſeful, when the things they contain do not make them conſiderable and equitable, readers will rather pity, than admire to find, that an author does not ſoar, whilſt he is clogged or depreſſed by the meanneſs of his ſubject. But becauſe ſome experience ſeems to promiſe, that their novelty and variety will procure the book in general a favourable entertainment; and, indeed, if I had written in a more uſual or a more ſolemn way, I ſhould, perchance, have had no readers but divines, or humaniſts, or devout perſons, or deſpiſers of the world, or (in a word) the maſters, or lovers of that one kind of learning, to which my ſubject did belong: but treating, as I do, of whatever chanced to come in my way, and conſequently of many very differing and unuſual things, curioſity will probably invite both the learned and the devout; both gentlemen and ladies; and, in a word, inquiſitive perſons of ſeveral kinds and conditions, to caſt their eyes upon theſe reflections; which, by their variety and ſhortneſs, will have this advantage, towards the making them entertained with patience, that ſcarce any of them will give him, that peruſes them, above half an hour's exerciſe of it.

AND as I thought it not any fault to have a regard to what was like to pleaſe a good part of the readers I wrote for, (though it would not elſe perhaps have pleaſed me, any more than it will the nicer palates of the criticks) ſo if theſe trifles chance to meet with half ſo kind a reception from the publick, as they have had from particular perſons, I ſhall not, perhaps, want the conſolation, which may be derived from the judgment of a great maſter of wit, who ſcrupled not to affirm, that he had rather his entertainments ſhould pleaſe the gueſts, than the cooks. Though they, that would compleat the good fortune of theſe papers, may do it more effectually, by addicting themſelves (as conſiderable perſons have been of late induced to do) to write occaſional reflections (how excellent ſoever they may prove) than by being kind to theſe; ſince having written them, not to get reputation, but company, I cannot but be unwilling to travel alone; and had rather be out-gone than not at all followed, and ſurpaſſed than not imitated.

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* So they call a certain room, artificially furniſhed with pictures, or other images of things, whereby to help the memory.

# A DISCOURSE TOUCHING OCCASIONAL MEDITATIONS.

## SECT. I.

### CHAP. I.

THE way of thinking, whoſe productions begin to be known by the name of Occaſional Meditations, is, if rightly practiſed, ſo advantageous, and ſo delightful, that it is pity the greateſt part, even of ſerious and devout perſons, ſhould be ſo unacquainted with it: and therefore, dear ſiſter, your deſire to bring this way of meditation into requeſt with ſome of our friends is that, which I cannot diſapprove. But I am ſo far from having the vanity to think, that the trifles of this kind, your commands make me trouble you with, would recommend occaſional reflections to thoſe, whoſe eyes they were not meant for, that I think my ſelf obliged to premiſe ſomething touching the uſefulneſs of this way of meditating, leſt the careleſs and unpoliſhed inſtances you will, I fear, meet with, among thoſe I now preſent you, ſhould diſparage and bring a prejudice upon compoſures of this kind in general: wherefore, judging it requiſite, to premiſe ſomething touching this way of thinking, I ſhall forthwith apply my ſelf to that taſk. And I ſhould judge it a very natural diſtribution to divide the following diſcourſe into two parts; the firſt of which ſhould contain ſome invitations to the cultivating this ſort of meditations, and the latter ſhould offer ſomething by way of method, towards the better framing of them. But leſt I ſhould at this time be hindered from treating of each of them diſtinctly, I will at preſent omit that diviſion, and endeavour in recompenſe ſo to deliver the motives I am to propoſe, that the firſt part of the diſcourſe may not appear maimed, though it be unattended by the ſecond; and yet the particulars that might compoſe the ſecond, may (if it prove convenient to mention them at this time) be commodiouſly enough inſerted in opportune places of the firſt.

Of inducements to this exerciſe, I might perhaps name many; but, for order's ſake, I ſhall comprize them in the enſuing five; the firſt whereof will take up the preſent ſection, and the remaining four, as many others.

## CHAP. II.

AND firſt, the way of meditating, I would recommend, conduces to keep the ſoul from idleneſs, and employments worſe than idleneſs; for while a man's thoughts are buſied about the preſent ſubjects of his reflections, our ghoſtly adverſary is diſcouraged to attempt that ſoul, which he ſees already taken up with ſomething, that is at leaſt innocent, if not good. If I had not elſewhere diſplayed the evil and danger of idleneſs, and repreſented it as a thing, which though we ſhould admit not to be in it ſelf a ſin, yet may eaſily prove a greater miſchief than a very great one, by at once tempting the tempter to tempt us, and expoſing the empty ſoul, like an uninhabited place, to the next paſſion or temptation, that takes the opportunity to ſeize upon it: If (I ſay) I had not elſewhere diſcourſed at large againſt idleneſs, I might here repreſent it as ſo formidable an enemy, that it would appear alone a ſufficient motive to welcome our way of meditation; that it baniſhes idleneſs. He that is verſed in making reflections upon what occurs to him; he that (conſequently) has the works of nature, and the actions of men, and almoſt every caſualty, that falls under his notice, to ſet his thoughts on work, ſhall ſcarce want themes to employ them on: and he that can (as it were) make the world vocal, by furniſhing every creature, and almoſt every occurrence, with a tongue to entertain him with, and can make the little accidents of his life, and the very flowers of his garden, read him lectures of ethicks or divinity; ſuch a one, I ſay, ſhall ſcarce need to fly to the tavern, or a worſe place to get a drawer, or gameſter (perhaps no better qualified) to help him to get rid of his time: ſuch a one will rather pity, than purſue thoſe, who think it their privilege to ſpend their whole life in diverſions from the main buſineſs of it; and out of an unſkilful, and ill-governed ſelf-love, are come to that paſs, that they cannot endure to be with themſelves. Such a one will not need to frequent the company of thoſe gameſters, that are ſure to loſe that, which all their winnings will never be able to buy, or to redeem; and expoſe themſelves coldly to as many caſualties, as even war could threaten; and voluntarily tempt thoſe paſſions it is the taſk of wiſdom to decline, and a virtue to ſuppreſs; loſing nothing but their time, without loſing their patience too, and commonly a great part of that reverence and ſubmiſſion they owe to him, of whom the ſcripture tells us, that even *of lots themſelves, the whole diſpoſal is his.* Nor will he need, for want of knowing what to do when he is alone, to make it his almoſt daily imployment, to make impertinent viſits to unſanctified companies, where ſometimes he may loſe his good name, often his innocence, oftner his zeal, and always his time.

Prov. xvi. 33.

And as the exerciſe, I would perſuade, will help to keep us from idleneſs; ſo will it, to preſerve us from harbouring evil thoughts, which there is no ſuch way to keep out of the ſoul, as to keep her taken up with good ones; as huſbandmen, to rid a piece of rank land of weeds, do often find it as effectual a courſe to ſow it with good ſeed, as to cut them down, or burn them up. And indeed, the thoughts of many a perſon, are oftentimes ſo active, and reſtleſs, that ſomething or other they muſt, and will perpetually be doing; and like unruly ſoldiers, if you have not a care to imploy them well, they will employ themſelves ill.

Wherefore, when a man hath once rendered this way of thinking familiar, ſometimes the ſubject of his meditation will lead him to thoughts, and excite affections, full of ſerenity and joy, like thoſe fair mornings, where the cloudleſs beams, and cheriſhing warmth of the ſun, inviting the lark to aſpire towards heaven, make her at once mount and ſing; and when the mind is raiſed to ſuch a welcome and elevated ſtate, to liſten to an ordinary temptation, a man muſt forego his pleaſure, as well as violate his duty, and in the difference betwixt the imployment that buſies him, and that whereto he is ſollicited to ſtoop, he will eaſily diſcern, that his innocence will not be the only thing, that he would loſe by ſo diſadvantageous a change; and ſometimes too, whether or no the imployment, that buſies his thoughts, happen to be ſo delightful, it will however appear to be ſo conſiderable, that it will ſeaſonably furniſh him with that excellent anſwer of *Nehemiah* to thoſe, that would have diverted him from building of the temple, to come to a treaty with them, *I am doing a great work*, (and ſuch indeed is the ſerving God, and the improving the mind, whether we conſider its importance, or its difficulty) *ſo that I cannot come down: why ſhould the work ceaſe, whilſt I leave it, and come down to you?* Which laſt expreſſion ſuits very well with the preſent caſe; ſince, when a pious ſoul is once got upon the wing of contemplation, ſhe muſt deſcend and ſtoop to exchange her converſe with heavenly objects, for one with earthly vanities; and much more muſt ſhe debaſe and degrade herſelf, if the things ſhe is tempted to, be luſts, which ſhe will thence clearly diſcern, to be as low as the hell they belong to, and deſerve. Nehem. vi. 3.

And as theſe objects will afford employment enough to our reflector, ſo will the wholeſome inſtructions they will ſuggeſt, incline him to ſhun thoſe ways of waſting his time, which they enable him eaſily to avoid. For I have obſerved this difference, betwixt ghoſtly dangers, and ordinary ones, whereas in military hazards, thoſe, that are the moſt forward to thruſt themſelves into dangers, are commonly the beſt able to ſurmount them; they, on the contrary, are wont to be the moſt fearful of temptations, that are the moſt reſolved, and beſt qualified to reſiſt them.

## CHAP. III.

NOR will the Meleteticks (or way, and kind of meditation) I would perſuade, keep men alone from ſuch groſs and notorious idleneſs; they may be aſked the queſtion, propoſed by the houſholder in the goſpel, *Why ſit ye here all the day idle?* But this way of thinking may in part keep men from the loſs of ſuch ſmaller parcels of time, as though a meer moraliſt would perhaps cenſure the neglect of them in others, yet a devout perſon would condemn it in himſelf; for betwixt the more ſtated employments, and important occurrences of human life, there uſually happen to be interpoſed certain intervals of time, which, though they are wont to be neglected, as being ſingly, or within the compaſs of one day, inconſiderable; yet in a man's whole life, they may amount to no contemptible portion of it. Now theſe uncertain parentheſes, (if I may ſo call them) or interludes, that happen to come between the more ſolemn paſſages (whether buſineſſes, or recreations) of human life, are wont to be loſt by moſt men, for want of a value for them, and even by good men, for want of ſkill to preſerve them: for though they do not properly deſpiſe them, yet they neglect, or loſe them, for want of knowing how to reſcue them, or what to do with them. But as though grains of ſand and aſhes be a part, but of a deſpicable ſmallneſs, and very eaſy, and liable to be ſcattered, and blown away; yet the ſkilful artificer, by a vehement fire, brings numbers of theſe to afford him that noble ſubſtance, glaſs, by whoſe help we may both ſee our ſelves, and our blemiſhes, lively repreſented, (as in looking-glaſſes) and diſcern celeſtial objects, (as with teleſcopes) and with the ſun-beams, kindle diſpoſed materials (as with burning glaſſes): ſo when theſe little fragments, or parcels of time, which, if not carefully looked to, would be diſſipated, and loſt, come to be managed Matth. xx. 6.

OF inducements to this exerciſe, I might perhaps name many; but, for order's ſake, I ſhall comprize them in the enſuing five; the firſt whereof will take up the preſent ſection, and the remaining four, as many others.

## CHAP. II.

AND firſt, the way of meditating, I would recommend, conduces to keep the ſoul from idleneſs, and employments worſe than idleneſs; for while a man's thoughts are buſied about the preſent ſubjects of his reflections, our ghoſtly adverſary is diſcouraged to attempt that ſoul, which he ſees already taken up with ſomething, that is at leaſt innocent, if not good. If I had not elſewhere diſplayed the evil and danger of idleneſs, and repreſented it as a thing, which though we ſhould admit not to be in it ſelf a ſin, yet may eaſily prove a greater miſchief than a very great one, by at once tempting the tempter to tempt us, and expoſing the empty ſoul, like an uninhabited place, to the next paſſion or temptation, that takes the opportunity to ſeize upon it: If (I ſay) I had not elſewhere diſcourſed at large againſt idleneſs, I might here repreſent it as ſo formidable an enemy, that it would appear alone a ſufficient motive to welcome our way of meditation; that it baniſhes idleneſs. He that is verſed in making reflections upon what occurs to him; he that (conſequently) has the works of nature, and the actions of men, and almoſt every caſualty, that falls under his notice, to ſet his thoughts on work, ſhall ſcarce want themes to employ them on: and he that can (as it were) make the world vocal, by furniſhing every creature, and almoſt every occurrence, with a tongue to entertain him with, and can make the little accidents of his life, and the very flowers of his garden, read him lectures of ethicks or divinity; ſuch a one, I ſay, ſhall ſcarce need to fly to the tavern, or a worſe place to get a drawer, or gameſter (perhaps no better qualified) to help him to get rid of his time: ſuch a one will rather pity, than purſue thoſe, who think it their privilege to ſpend their whole life in diverſions from the main buſineſs of it; and out of an unſkilful, and ill-governed ſelf-love, are come to that paſs, that they cannot endure to be with themſelves. Such a one will not need to frequent the company of thoſe gameſters, that are ſure to loſe that, which all their winnings will never be able to buy, or to redeem; and expoſe themſelves coldly to as many caſualties, as even war could threaten; and voluntarily tempt thoſe paſſions it is the taſk of wiſdom to decline, and a virtue to ſuppreſs; loſing nothing but their time, without loſing their patience too, and commonly a great part of that reverence and ſubmiſſion they owe to him, of whom the ſcripture tells us, that even *of lots themſelves, the whole diſpoſal is his.* Nor will he need, for want of knowing what to do when he is alone, to make it his almoſt daily imployment, to make impertinent viſits to unſanctified companies, where ſometimes he may loſe his good name, often his innocence, oftner his zeal, and always his time.

Prov. xvi. 33.

AND as the exerciſe, I would perſuade, will help to keep us from idleneſs; ſo will it, to preſerve us from harbouring evil thoughts, which there is no ſuch way to keep out of the ſoul, as to keep her taken up with good ones; as huſbandmen, to rid a piece of rank land of weeds, do often find it as effectual a courſe to ſow it with good ſeed, as to cut them down, or burn them up. And indeed, the thoughts of many a perſon, are oftentimes ſo active, and reſtleſs, that ſomething or other they muſt, and will perpetually be doing; and like unruly ſoldiers, if you have not a care to imploy them well, they will employ themſelves ill.

WHEREFORE, when a man hath once rendered this way of thinking familiar, ſometimes the ſubject of his meditation will lead him to thoughts, and excite affections, full of ſerenity and joy, like thoſe fair mornings, where the cloudleſs beams, and cheriſhing warmth of the ſun, inviting the lark to aſpire towards heaven, make her at once mount and ſing; and when the mind is raiſed to ſuch a welcome and elevated ſtate, to liſten to an ordinary temptation, a man muſt forego his pleaſure, as well as violate his duty, and in the difference betwixt the imployment that buſies him, and that whereto he is ſollicited to ſtoop, he will eaſily diſcern, that his innocence will not be the only thing, that he would loſe by ſo diſadvantageous a change; and ſometimes too, whether or no the imployment, that buſies his thoughts, happen to be ſo delightful, it will however appear to be ſo conſiderable, that it will ſeaſonably furniſh him with that excellent anſwer of *Nehemiah* to thoſe, that would have diverted him from building of the temple, to come to a treaty with them, *I am doing a great work*, (and ſuch indeed is the ſerving God, and the improving the mind, whether we conſider its importance, or its difficulty) *ſo that I cannot come down: why ſhould the work ceaſe, whilſt I leave it, and come down to you?* Which laſt expreſſion ſuits very well with the preſent caſe; ſince, when a pious ſoul is once got upon the wing of contemplation, ſhe muſt deſcend and ſtoop to exchange her converſe with heavenly objects, for one with earthly vanities; and much more muſt ſhe debaſe and degrade herſelf, if the things ſhe is tempted to, be luſts, which ſhe will thence clearly diſcern, to be as low as the hell they belong to, and deſerve.

Nehem. vi. 3.

AND as theſe objects will afford employment enough to our reflector, ſo will the wholeſome inſtructions they will ſuggeſt, incline him to ſhun thoſe ways of waſting his time, which they enable him eaſily to avoid. For I have obſerved this difference, betwixt ghoſtly dangers, and ordinary ones, whereas in military hazards, thoſe, that are the moſt forward to thruſt themſelves into dangers, are commonly the beſt able to ſurmount them; they, on the contrary, are wont to be the moſt fearful of temptations, that are the moſt reſolved, and beſt qualified to reſiſt them.

## CHAP. III.

NOR will the Meleteticks (or way, and kind of meditation) I would perſuade, keep men alone from ſuch groſs and notorious idleneſs; they may be aſked the queſtion, propoſed by the houſholder in the goſpel, *Why ſit ye here all the day idle?* But this way of thinking may in part keep men from the loſs of ſuch ſmaller parcels of time, as though a meer moraliſt would perhaps cenſure the neglect of them in others, yet a devout perſon would condemn it in himſelf; for betwixt the more ſtated employments, and important occurrences of human life, there uſually happen to be interpoſed certain intervals of time, which, though they are wont to be neglected, as being ſingly, or within the compaſs of one day, inconſiderable; yet in a man's whole life, they may amount to no contemptible portion of it. Now theſe uncertain parentheſes, (if I may ſo call them) or interludes, that happen to come between the more ſolemn paſſages (whether buſineſſes, or recreations) of human life, are wont to be loſt by moſt men, for want of a value for them, and even by good men, for want of ſkill to preſerve them: for though they do not properly deſpiſe them, yet they neglect, or loſe them, for want of knowing how to reſcue them, or what to do with them. But as though grains of ſand and aſhes be a part, but of a deſpicable ſmallneſs, and very eaſy, and liable to be ſcattered, and blown away; yet the ſkilful artificer, by a vehement fire, brings numbers of theſe to afford him that noble ſubſtance, glaſs, by whoſe help we may both ſee our ſelves, and our blemiſhes, lively repreſented, (as in looking-glaſſes) and diſcern celeſtial objects, (as with teleſcopes) and with the ſun-beams, kindle diſpoſed materials (as with burning glaſſes): ſo when theſe little fragments, or parcels of time, which, if not carefully looked to, would be diſſipated, and loſt, come to be managed

Matth. xx. 6.

by a ſkilful contemplator, and to be improved by the celeſtial fire of devotion, they may be ſo ordered, as to afford us both looking-glaſſes to dreſs our ſouls by, and perſpectives to diſcover heavenly wonders, and incentives to inflame our hearts with charity and zeal. And ſince goldſmiths and refiners are wont all the year long carefully to ſave the very ſweepings of their ſhops, becauſe they may contain in them ſome filings, or duſt of thoſe richer metals, gold and ſilver; I ſee not why a Chriſtian may not be careful, not to loſe the fragments and leſſer intervals of a thing incomparably more precious than any metal, time: eſpecially, when the improvement of them, by our Meleteticks, may not only redeem ſo many portions of our life, but turn them to pious uſes, and particularly to the great advantage of devotion.

And indeed, the affairs and cuſtoms of the world, the employments of our particular callings, the allowable recreations, that health, or wearineſs requires, and the multitude of unforeſeen, and ſcarce evitable avocations, that are wont to ſhare our time among them, leave us ſo little of it, to employ in the ſet and ſolemn exerciſes of devotion, and make thoſe ſo unfrequent, that our hearts are in great danger of being, by the buſineſs, and pleaſures, and hurry of the world, if not perverted from aſpiring to, at leaſt too long diverted from enjoying communion with God, and kept too much ſtrangers to him; if in the long intervals of our more ſolemn exerciſes of devotion, we be not careful to lay hold on the ſhort and tranſient opportunities of cheriſhing, and reviving that grace in us, and do not by the riſes given us by the things that occur, take occaſion to make frequent, though but ſhort flights heavenwards, in extemporary reflections, ſerious ſoliloquies, piercing ejaculations, and other mental, either exerciſes, or expreſſions of devotion: by which means, we may make thoſe very objects, and occaſions, that would diſcourage, or at leaſt diſtract our minds, elevate and animate them; as *Jonathan* made thoſe very things, whereby his enemies, the Philiſtines, ſought to intrap, or deſtroy him, incouragements to fight with them, and omens of his victory over them. And as ſcarce any time is ſo ſhort, but that things ſo agile, and aſpiring, as the flames of a devout ſoul, may take flight to heaven, (as *Nehemiah* could find time to dart up a ſucceſsful prayer to the throne of grace, whilſt he ſtood waiting behind the king of *Perſia*'s chair) ſo by theſe extemporary reflections, as well as by other mental acts of piety duly made, a devout ſoul may not only reſcue theſe precious fragments of time, but procure eternity with them.

## SECT. II.

### CHAP. I.

A Second inducement to the practice of making occaſional meditations, is, that for an exerciſe of devotion, it is very delightful, and that upon ſundry accounts.

For firſt, variety is a thing ſo pleaſing to human nature, that there are many things, which it, either alone, or chiefly, recommends to us, and it is rarely ſeen, that we love the ſame things, very much, and very long; and of things that elſe would appear equally good, we uſually think that the better, which happens to be another. Now, a perſon addicted to make occaſional meditations may be ſupplied with ſubjects, whoſe variety is ſcarce imaginable: for the works of nature and of art are not the only objects, that often preſent themſelves to our reflector's conſideration; the revolutions of governments, the fates of kingdoms, the riſe and ruin of favourites; and, on the other ſide, the moſt ſlight and trivial occurrences; and in ſhort, all that he ſees happen from the higheſt tranſactions, to the ſlighteſt circumſtances, incident to human affairs, may afford matter of contemplation to a perſon diſpoſed to it. The mind of man is ſo comprehenſive, and ſo active a faculty, that it can force its paſſage into thoſe imaginary ſpaces, that are beyond the outermoſt part of the outermoſt heaven, and can in a moment return back, to conſider the ſmalleſt circumſtances of the meaneſt of human affairs; ſo that the thinking faculty, being equally fit, and diſpoſed to reflect upon the works of God, and the actions of men, how unlikely is it, that it ſhould want variety of ſubjects to be employed on, whilſt the whole world makes but a part of its object; and the ſeveral productions of nature and art, of the providence of God, and the will of man, may be ſo many ways conſidered, and ſo variouſly compounded, that they may well be ſuppoſed capable of affording occaſions to notions and reflections far more numberleſs than themſelves; ſo that the moſt vigorous, and the moſt active ſoul, is in leſs danger of wanting freſh game, than thoughts to purſue ſuch endleſs variety of it.

BESIDES, whereas men are wont, for the moſt part, when they would ſtudy hard, to repair to their libraries, or to ſtationers ſhops; the occaſional reflecter has his library always with him, and his books lying always open before him, and the world it ſelf, and the actions of the men that live in it, and an almoſt infinite variety of other occurrences being capable of proving objects of his contemplation; he can turn his eyes no whither, where he may not perceive ſomewhat or other to ſuggeſt him a reflection.

BUT that, which may much indear ſuch meditations, is, their ſurprizing even him, whoſe thoughts they are: For one of the chief accounts, upon which wit itſelf is delightful, is, in very many caſes, the unexpectedneſs of the things that pleaſe us; that unexpectedneſs being the higheſt degree of novelty, which, as I freſhly noted, does exceedingly gratify moſt men's minds. We need not in this caſe, as in moſt others, make an uneaſy preparation to entertain our inſtructors; for our inſtructions are ſuddenly, and, as it were out of an ambuſcade, ſhot into our mind from things, whence we never expected them, ſo that we receive the advantage of learning good leſſons, without the trouble of going to ſchool for them, which to many appears the greateſt trouble, that is to be undergone, for the acquiſt of knowledge. But though theſe irradiations of light be oftentimes ſudden, as that which we receive from flaſhes of lightening, yet it is not always upon the ſingle account of this ſuddenneſs, that the inſtructions, preſented us by occaſional meditations, have an unexpectedneſs; for oftentimes, the ſubject, that is conſidered, appears not to be any thing at all of kin to the notion it ſuggeſts. And there are many of theſe reflections, whoſe titles, though they name the occaſion of them, do ſo little aſſiſt, even an ingenious reader, to gueſs what they contain, that if you tell him what is treated of, he will ſcarce imagine, how ſuch thoughts can be made to have a relation to ſuch remote ſubjects; and the informations we receive from many creatures, and occurrences, are oftentimes extremely diſtant from what, one would conjecture to be the moſt obvious, and natural thoughts thoſe themes are fitted to preſent us; though, when the circumſtances are thoroughly examined, and conſidered, the informations appear proper enough. Thus, when a navigator ſuddenly ſpies an unknown veſſel afar off, before he has hailed her, he can ſcarcely, if at all, conclude what he ſhall learn by her; and he may from a ſhip, that he finds perhaps upon ſome remoter coaſt of *Africa*, or the *Indies*, meet with informations concerning his own country, and affairs. And thus ſometimes a little flower may point us to the ſun, and by caſting our eyes down to our feet, we may in the water ſee thoſe ſtars, that ſhine in the firmament, or higheſt viſible heaven.

## CHAP. II.

AND laſtly, the pleaſantneſs of theſe meditations to him, that hath attained ſkill in making them, will, if he be not much mortified, be much increaſed by their being proofs, as well as effects, of ſkill. To be able to take up inſtructions in books, that are repleniſhed with them, and where they are purpoſely and diſtinctly exhibited in the form of inſtructions, requires rather that a man be docile than ingenious: but to be able to collect moral and ſpiritual documents out of a book of hieroglyphicks, or from a landſkip or a map, is more than every attentive conſiderer can do, and is that, which argues ſomething of dexterouſneſs and ſagacity, that is not very ordinary. And ſo, from ethical or theological compoſures, to take out leſſons, that may improve the mind, is a thing much inferiour to the being able to do the like out of the book of nature, where moſt matters, that are not phyſical, if they ſeem not to be purpoſely veiled, are at leaſt but darkly hinted. And methinks there is ſuch a difference betwixt him, that but takes up inſtructions in books of morality and devotion, and him that by occaſional reflections derives them from the book of nature, and the accidents he chances to take notice of, as there is betwixt an ant, that contributes nothing either to the production or improvement of the corn ſhe lays up and feeds on, but only carries away that, which ſhe finds ready formed into its little granary or repoſitory; and the induſtrious bee, who, without ſtealing from flowers any thing that can prejudice them, does not only gather, but improve and tranſform her food, and live on that, which otherwiſe would be uſeleſs; and beſides, not only has the pleaſure to gather its food from flowers, and from variety of them, but lives upon honey, an aliment, that is as ſweet and delicious as nutritive It was doubtleſs a very great pleaſure to *Æſop*, that by his ingenious fictions he could, in a manner, lend reaſon and ſpeech to lions, foxes, crows, and other animals, to whom nature had denied both; and I know not why it ſhould be leſs delightful, by occaſional reflections, to turn not only birds and beaſts, but all kinds of creatures in the world, as well mute and inanimate, as irrational, not only into teachers of ethicks, but oftentimes into doctors of divinity, and by compelling ſenſeleſs creatures to reveal truths to us, that they were never acquainted with themſelves, perform really ſomething like that, which was but pretended by the ancient augurs and other diviners the heathen world admired; who took upon them, by the caſual flights of birds, and the inſpection of the intrails of beaſts, to learn the will of heaven. It is a piece of ſkill, for which mathematicians have been deſervedly admired, and which is little leſs pleaſing to thoſe that have it, than wonderful to thoſe that have it not, that as if artiſts were able to preſcribe to the ſun and moon, and the reſt of the luminous globes of heaven, both their pace and their ſtages, they can make that inexhauſted fountain of light, at ſo immenſe a diſtance, by the ſhadow of a little gnomon, fitly placed, give us an exact account of all the journeys he performs in the zodiack: but perhaps, it is neither a leſs noble nor a leſs delightful piece of ſkill, to be able, by an innocent kind of necromancy, to conſult the dead, and conjure up worm-eaten carcaſſes out of their moſſy graves, without fearing to hear from them ſuch diſmal diſcourſes, as *Saul* had from dead *Samuel*, and to make, not the ſtars only, but all the creatures of nature, and the various occurrences that can fall under our notice, conſpire to inrich us with inſtructions they never meant us; ſince the motion of the celeſtial lights are known, certain, and invariable; but theſe particulars are neither to be defined by number, nor limited by rules. Not to ſay, that this ſecret does as much excel that other, which recommends aſtronomy, as wiſdom does ſcience, and is as much the more uſeful of the two, as to know how to paſs away our time is more profitable, than to know how our time paſſes away.

But there is a fourth particular, which, though ſomewhat leſs directly than the three I have already diſcourſed of, may be reduced to the pleaſantneſs of occaſional meditations; and it is, that whereas our innate ſelf-love is wont to make any thing, that minds us of our faults, exceedingly uneaſy and unwelcome; in the diſcoveries, that, by this way of thinking, are made us of what is amiſs, the uneaſineſs is very much allayed, and the pill very well gilt. For there are two main things, that conduce to the ſweetning of reproofs, and to keep men from being offended at them; the one is, when they come from a perſon, whom we love, and whom we believe to love us, and to have no other deſign in diſpleaſing us than that of ſerving us: and the other is, that the diſcovery, that is made us of our faults, be ſweetned by acknowledgments of our having qualities of a commendable nature, whence wiſe reprovers uſually mingle, and, as it were, brew their reprehenſions with praiſes. Now, both theſe pleaſing vehicles, if I may ſo call them, and correctives of reproofs, concur in thoſe we meet with in making occaſional reflections. For, in theſe caſes, being our own inſtructors, and our own conſciences being the makers of the application, we cannot ſuſpect the reprehenſions to come from perſons, that either miſtake us, or are partial againſt us; and that truth, which a man's conſcience applies to him, being found out by the ſagacity of his own underſtanding, extracting from objects that, which every conſiderer would not have picked out thence; it may very often happen, that the ſame reflection will diſcover to a man his excellencies, as well as make him take notice of his faults: and that which makes him condemn the diſorders of his affections, may argue, and thereby commend, the goodneſs of his parts.

## CHAP. III.

I Know, it may be objected againſt the pleaſantneſs of the mental exerciſe I have been ſpeaking of, that to make occaſional meditations is a work too difficult to be delightful.

In anſwer to this, I might repreſent, that there are employments, wherein their being attended with ſomewhat of difficulty, is ſo far from deterring us, that it recommends them: as we ſee, that in hunting and hawking, the toil, that muſt be undergone, is ſo much an indearment of the recreation, of which it makes a great part, that when it happens, that we do not meet with difficulties enough, we create new ones; as when huntſmen give the hare law, (as they ſpeak) for fear of killing her, before they have almoſt killed their horſes, and perhaps themſelves, in following her. Yet I ſhall rather chuſe to make a more direct anſwer, by obſerving, that the difficulties imagined in the practice I am treating of ſeem to ariſe, not ſo much from the nature of the thing it ſelf, as from ſome prejudices and miſapprehenſions, that are entertained about it, eſpecially the following two.

The firſt is a needleſs ſcruple, which makes ſome fancy themſelves obliged to confine their thoughts to the ſubject, that ſet them on work. And this dwelling long upon one theme is to many men a thing uneaſy and tedious enough. But for my part, I ſee no neceſſity of ſuch a ſtrictneſs; and I have often obſerved the thoughts ſucceſsfully to follow objects of a quite differing nature from thoſe that were firſt ſtarted, from which perhaps, though more obſtinately purſued, very little inſtruction or advantage would have been obtained. And it not unfrequently happens, that men trouble themſelves in vain to make any profitable uſe of the conſiderations of thoſe firſt objects, where the thoughts being licenſed to expatiate themſelves, they do often at length pitch upon ſomewhat or other that is inſtructive, and at which, perhaps, they aimed at the very firſt, though they attained it by degrees, and purſued it by winding and untraced ways. As when we let a grey-hound looſe in a warren, we confine him not to the firſt rabbit he makes after, ſince we ſee it frequently happens, that one ſets him a running, and another proves his quarry. Nor do I conceive ſuch a practice diſagreeable to the nature of occaſional meditations, nor to be excluded by their name; for that appellation may well enough be applied to thoſe emergent thoughts, which fortuitous occaſions did awaken or ſuggeſt to us; nor is it neceſſary, that our thoughts be always calculated for the ſubject that excited them, provided we thence took occaſion to think; ſo that in ſome caſes, the occaſion is not ſo much the theme of the meditation, as the riſe. For my part, I am ſo little ſcrupulous in this matter, that I would not confine occaſional meditations to divinity it ſelf, though that be a very comprehenſive ſubject; but am ready to allow men's thoughts to expatiate much farther, and to make of the objects they contemplate not only a theological and a moral, but alſo a political, and œconomical, or even a phyſical uſe. And I doubt, whether the groundleſs imagination, that occaſional reflections ought to be confined to matters of devotion, or, at furtheſt, of morality, have not much helped to keep our Meleteticks ſo little cultivated, as hitherto they have been. And indeed there is ſo perfect an harmony, and ſo near a kindred, betwixt truths, that, in many caſes, the one does either find out, or fairly hint or elſe illuſtrate or confirm, the other. And it is no wonder, that divers of them ſhould belong to the ſame object, and be deduced from it. And if men were ſollicitous to apply the things they take notice of in occaſional objects, to the diſcovery or illuſtration of œconomical, political, or phyſical matters, it would probably bring ſuch kind of thoughts more into requeſt with ſeveral ſorts of men, and poſſibly conduce to the improvement of thoſe parts of knowledge themſelves.

## CHAP. IV.

THE other thing I propoſed to mention, as that, which diſcourages many from the addicting themſelves to make occaſional meditations, is a fancy, that to practiſe this kind of thinking, one is obliged to the trouble of writing down every occaſional reflection, that employs his thoughts; and they conclude it far eaſier to forbear making any, than to write down all. But to do this, were to undertake a taſk no leſs unneceſſary than tedious. Thoſe meditations indeed, that have ſome excellency in them, that fits them to inſtruct others, ſhould for that purpoſe be kept from periſhing; and thoſe that were not conceived without ſome extraordinary affection in a man's ſelf, ſhould be carefully purſued, as bellows to blow or rekindle devotion, by reminding us of the devout thoughts the like objects had excited in us. But for the reſt of our occaſional reflections, though they fill our heads, they need not employ our hands, as having performed all the ſervice, that need be expected from them, within the mind already.

NOR would I have any man be diſcouraged from this way of thinking, that cannot expreſs ſo much wit or eloquence in occaſional meditations, as perhaps he may aſpire to. For, beſides that much ſubtilty of wit is not to be expected, or at leaſt exacted, in this kind of compoſures, where we commonly make uſe of things rather out of haſte than choice, as frequently being but the firſt thoughts we meet with, not the beſt we have; beſides this, I ſay, that which ought moſt to endear this ſort of reflections to a Chriſtian, is rather that they cheriſh piety, than that they expreſs wit, and help to make the man good, whether or no they make his ſtyle be thought ſo. It were injurious to nature to fancy, that the fig-tree derives no benefit from the rain and ſun, becauſe they do not make it, like other trees, flouriſh with bloſſoms, more gaudy than neceſſary; though without previous buds it brings forth welcome fruits. Not to add, that the difficulty of framing occaſional meditations need not be eſtimated by that, which we find when we firſt addict ourſelves to the making of them; for practice will by degrees ſo much leſſen that difficulty, that after a while we ſhall find, that occaſional thoughts will need but ſmall invitation to frequent thoſe minds, where they meet with a kind entertainment. And though men ſhould be reduced to purchaſe this habitude at the rate of a little difficulty, I doubt not but they will find the benefit of it, when gotten, richly to recompenſe the trouble of acquiring it. Nor will the practice, that muſt contribute to the attainment of a reaſonable degree of ſkill in making them, be half ſo troubleſome when thoſe exerciſes but make up the habitude, as they will prove facile and delightful when they flow from it.

## SECT. III.

## CHAP. I.

THE third grand advantage, that may be derived from the cuſtom of making occaſional meditations, is, that it conduces to the exerciſe and improvement of divers of the faculties of the mind. And this it may do upon ſeveral accounts.

1. For, in the firſt place, it accuſtoms a man to an attentive obſervation of the objects, wherewith he is converſant. Whereas there is ſcarce any thing, that may not prove the ſubject of an occaſional meditation; ſo the natural propenſity we have to manage well the themes we undertake to handle, unperceivably ingages us to pry into the ſeveral attributes and relations of the things we conſider, to obtain the greater plenty of particulars, for the making up of the more full and compleat parallel betwixt the things, whoſe reſemblances we would ſet forth. By which means a man often comes to diſcover a multitude of particulars, even in obvious things, which, without ſuch an ingagement to attention, he would never have minded, and which common beholders take no notice of. And though it may ſeem, that the habit, produced by the practice of occaſional meditating, ſhould accuſtom a man to heed only ſuch objects, as are like to ſuggeſt to him devout thoughts; yet, not to mention now, that I ſhall advertiſe you anon, that there is no neceſſity of confining occaſional meditations to matters devout or theological, I ſhall only repreſent, that, ſince we know not, before we have conſidered the particular objects that occur to us, which of them will, and which of them will not, afford us the ſubject of an occaſional reflection, the mind will, after a while, be ingaged to a general and habitual attention, relating to the objects, that preſent themſelves to it. Beſides that though we ſhould at firſt apply our heedfulneſs to circumſtances of only ſome few ſorts of objects; yet the habit being once acquired, would eaſily reach to others than thoſe that firſt occaſioned it: as men, that by learning to ſing anthems are come to have critical ears, will be able to judge, much better than they could before, of the reſemblances and differences of tones in other ſongs, and will take notice of divers particularities in voices, which would not be heeded by an unpractiſed ear. And as we have made it appear, that the way of thinking, we would recommend, does very much diſpoſe men to an attentive frame of mind; ſo, that ſuch a frame or diſpoſition is a great advantage in the whole courſe of a man's life, will not appear improbable to him, who duly conſiders, that ſince attention, like a magnifying glaſs, ſhews us, even in common objects, divers particularities, undiſcerned by thoſe who want that advantage, it muſt

needs make the things, he is converſant with, afford the conſiderer much more of inſtruction than they obtrude upon the ordinary regardleſs beholder; and, conſequently, this exerciſe of the mind muſt prove a compendious way to experience, and make it attainable without grey-hairs; for that, we know, conſiſts not in the multitude of years, but of obſervations, from numbers and variety of which it reſults. Nor is there any reaſon, why prudence ſhould be peculiarly aſcribed to the aged, except a ſuppoſition, that ſuch perſons, by having lived long in the world, have had the opportunity of many and various occurrences to ripen their judgment: ſo that if one man can by his attention make, as well he may in a ſmall compaſs of time, as great a number of obſervations as leſs heedful perſons are wont to do in a longer, I ſee not, why ſuch a man's experience may not be equal to his that has lived longer; for it matters not much, whether a man make a competent number of obſervations, in much time or in little, provided he have made them well.

## CHAP. II.

THE practice I would recommend, accuſtoms a man to make reflections upon the things he takes notice of, and ſo, by exerciſing, improves his reaſoning faculty. For, as moſt men have much more ſtrength and agility in the right hand than in the left; and, generally ſpeaking, thoſe limbs of the body that are moſt exerciſed, are ſtronger than the reſt of the ſame kind; ſo the faculties of the mind are improved by exerciſe, and thoſe, that we frequently employ, grow thereby the more vigorous and nimble. And, for my part, I have been often inclined to think, that the chief advantage, that the reaſoning faculty derives from the inſtitution received in logic-ſchools, comes not ſo much from the precepts themſelves, which are pretended to make up an art of reaſoning, as from the frequent exerciſes, that, by occaſion of ſuch precepts, the ſtudents are put upon. And, perhaps, if men were obliged to read the controverſies of ſubtile wits, and to engage in frequent diſputations, both premeditated and extemporary, it would add little leſs of readineſs and acuteneſs to their wits, though they diſputed of other matters than ſuch as properly belong to logic, and were not before imbued with the precepts of that art: as we ſee, that the uſe of ſinging with thoſe, that can ſing well, does much improve one's voice, both as to ſtrength and clearneſs, whatever the tunes or ſongs be, that are ſung, and how little ſoever thoſe, with whom one ſings, make it their buſineſs to teach him the art of muſic.

BUT this is only conjecture; and whether it be true or no, yet this I am confident is ſo, that the bringing of a man to be a thinking and a reflecting perſon is to procure him ſo great an advantage, as though it were the only one may juſtly endear to him the cuſtom of making occaſional meditations; and he, that could bring this practice into the requeſt it deſerves, would do a greater piece of ſervice, not only to the particular perſons he perſuades, but to mankind in general, than the greater part of good men themſelves ſeem to be aware of. For though God having been pleaſed to make reaſon the chief part of our nature, among the various objects, that daily occur to us, it can ſcarce be, but that ſome or other will in a manner obtrude ſome notions even upon the unattentive; yet certainly, all that has been found worthy of mankind in mathematics, philoſophy, and other kinds of learning, has been attained by thinking men, or by a frequent and regular practice of employing the thoughts. And leſt it ſhould be objected, that theſe various and elaborate effects of aſſiduous meditation were the productions only of philoſophers, or other men of ſpeculative heads; let us but conſider, that though gallants and courtiers do ſeldom love to tire themſelves with

thinking, and are as ſeldom fond of writing books, not to add, fit to write them; and though love be not the fruitfulleſt, that may be pitched on, yet that paſſion, and ſome particulars relating to it, frequently buſying their thoughts, and being ſeveral ways conſidered by them, has been diſplayed and contrived even by ſuch writers, as I have been juſt now mentioning, into thoſe numerous plays, that daily employ the ſtage, and thoſe voluminous romances, that are too often the only books, which make up the libraries of gallants, and fill the cloſets of ladies. He that moſt truly called himſelf the *Truth*, tells us, that the devil is not only a *lyar*, but the John viii, 44.
*father of lyes*, that is, the great patron and promoter of falſhood, and, as ſuch, he ſtudiouſly oppoſes all uſeful truths; not only thoſe, for which we muſt be beholden to revelation, but thoſe alſo, which may be attained by ratiocination, and the well-regulated exerciſe of our natural faculties; and he were much leſs an adverſary and an old ſerpent than he is, if his enmity to God and man did not juſtly make him think, that ſcarce any thing is more his intereſt than ſollicitouſly to divert men from thinking, and diſcourage them in it, there being few things, whereby he could more effectually oppoſe at once both the glory of God, and the good of men. And ſure, if ſo ſubtile an adverſary did not think it very much his intereſt to be ſollicitous about this matter, it could not be, that men ſhould chuſe for a privilege, the laying aſide that faculty of meditating, which is indeed ſo much their privilege, that, if experience did not convince the contrary, I could never ſuſpect, that the non-employing of their thoughts could be their choice rather than their puniſhment; and that rational creatures, eſpecially profeſſing Chriſtianity, ſhould either keep idle, or confine to employments worſe than idleneſs, ſo noble and improveable a faculty, that enables an ingenious man to pry into the inmoſt receſſes of myſterious nature, and diſcover there ſo much of the wiſdom, power, and goodneſs of the Author, as are moſt fit to give the diſcoverer a high and devout veneration for thoſe excellencies. A faculty, whereby an inquiſitive ſoul may expatiate itſelf through the whole immenſity of the univerſe, and be her own teacher in a thouſand caſes, where the book is no leſs delightful than the leſſons are inſtructive: A faculty (to conclude) by whoſe help the reſtleſs mind having dived to the lowermoſt parts of the earth, can thence in a trice take ſuch a flight, that having traverſed all the corporeal heavens, and ſcorned to ſuffer herſelf to be confined within the very limits of the world, ſhe roves about in the ultra-mundane ſpaces, and conſiders how far they reach.

## CHAP. III.

III. BESIDES the two already mentioned advantages, which the intellectual part of the mind may derive from the practice of occaſional reflections, I ſhould not ſcruple to add a third, if there were not too juſt cauſe of apprehending, that my writings may diſcredit any thing, that comes propoſed of that nature by no better a pen, and that the manner of what I am about to deliver may diſparage the matter. But ſince, from the experience even of purblind and dim-ſighted perſons, good perſpectives may be, not improperly, nor unſucceſsfully, recommended, though their native and peculiar debility of ſight keep them from being able to ſee as clear and as far through ſuch glaſſes as other men can do, if themſelves can, by the uſe of them, do far more than they could without them; I will adventure to ſpeak of an improvement I cannot boaſt of, leſt by ſuppreſſing the mention of an advantage, becauſe I cannot make it, I ſhould ſeem either vain, or envious, as well as dull. I ſhall then take notice, that the Meleteticks we are conſidering, may, where it finds a capable and diſpoſed ſubject, much improve that nimble and acceptable faculty of the mind, whereby ſome men have a readineſs and ſubtilty in conceiving things, and a quickneſs and neatneſs in expreſſing them; all which the cuſtom of ſpeaking comprehends under the name of wit; which pleaſing, and (if well managed) uſeful quality, the exerciſe I am diſcourſing of may three or four ſeveral ways promote.

FOR (firſt) the accuſtoming one's ſelf to make extemporal reflections, and that upon all kind of occaſions, does by degrees bring the mind to a readineſs of conception, which keeps a man from being eaſily ſurprized by the ſubject he has occaſion to conſider, and enables him oftentimes to ſurprize his hearers; and that ſuch a kind of ſurprize is one of the moſt endearing circumſtances of the productions of wit, he muſt not have much conſidered the nature of them, that ignores.

NEXT, the ſame exerciſe inures a man to draw his conceptions from the very nature of the thing he ſpeaks of; which, among thoſe that can judge of wit, is held a far greater ſign of it, than the ſaying things more ſpecious and elaborate, that appear to be antienter than the occaſion; as is uſual in epigrams, and other ſolemn premeditated pieces of wit, where oftentimes the thoughts were not made for the themes, but before them: whereas the ſuddenneſs of a good occaſional reflection, and its congruity to that which gave it riſe, perſuades the hearers, that the ſpeaker's wit is of its own growth, and is rather ſuggeſted by the occaſion, than barely applied to it.

A THIRD way, whereby our Meleteticks may conduce to wit, is, by bringing thoſe, that uſe to write their thoughts, to what may be called a certain *ſuppleneſs of ſtyle*; for when a man treats of familiar, or of ſolemn ſubjects, he is ſo much aſſiſted by the received phraſes and manners of ſpeaking, that are wont to be imployed about them, that being ſeldom at a loſs for convenient expreſſions, his wit is ſeldom diſtreſſed how to furniſh him with words fit for his turn. But the ſubjects, that invite occaſional reflections, are ſo various and uncommon, and oftentimes ſo odd, that, to accommodate one's diſcourſe to them, the vulgar and received forms of ſpeech will afford him but little aſſiſtance; and to come off any thing well, he muſt exerciſe his invention, and put it upon coining various and new expreſſions, to ſuit that variety of unfamiliar ſubjects, and of occaſions, that the objects of his meditation will engage him to write of. And by this difficult exerciſe of his inventive faculty, he may by degrees ſo improve it, and, after a while, attain to ſo pliant a ſtyle, that ſcarce any thought will puzzle him to fit words to it, and he will be able to cut out expreſſions, and make them ſit cloſe to ſuch ſubjects, as a perſon unaccuſtomed to ſuch kind of compoſures would find it very difficult to write of, with any thing of propriety.

## CHAP. IV.

IT remains, that I mention one way more, and that a conſiderable one, whereby the practice of occaſional reflections may contribute to the improvement of wit; and that is, by ſupplying men with ſtore and variety of good compariſons.

How great, and how acceptable, a part of wit that is, which has the advantage to be expreſſed by apt ſimilitudes, every man's own experience, if he pleaſe to conſult it, may, in ſome meaſure, inform him. And certainly, there is no one part of wit, that is ſo generally applicable to all kind of perſons; for good compariſons ſerve equally to illuſtrate, and to perſuade; the greateſt wits diſdain them not, and even ordinary wits are capable to underſtand them, and to be affected by them: and if a ſermon, or a long diſcourſe, be enriched with one apt compariſon, what part ſoever elſe be forgotten, that will be ſure to be remembred. And a but plauſible argument, dreſſed up in fine ſimilitudes, ſhall be more prevalent among the generality of men, than a demonſtration propoſed in a naked ſyllogiſm; and therefore, the ancient ſages did ſo much chuſe to imploy a figurative way of delivering their thoughts, that when they could not furniſh themſelves with reſemblances fit for their turns, they would deviſe parables, and apologues, to recommend what they ſaid to the attention and memory of thoſe they would work upon. And thoſe famous orators, who, though they lived in commonwealths, did, by their eloquence, exerciſe a more than monarchical government there, and who, by their inchanting tongues, ruled thoſe warlike people, whoſe ſwords had made them maſters of the world; thoſe imperial wits, I ſay, whoſe oratory performed ſuch wonders, performed them chiefly by the help of their happy compariſons, which alone contributed more to their ſucceſs, than almoſt all the other perſuaſive figures of their triumphant rhetorick; lucky compariſons being indeed thoſe parts of wit, that as well make the ſtrongeſt impreſſions upon the mind, as they leave the deepeſt on the memory. Now, as the being furniſhed with apt compariſons does ſo very much conduce to the making a man's diſcourſes and writings appear witty, ſo there is ſcarce any thing more fit and likely to ſupply a man with ſtore and variety of compariſons, than the cuſtom of making occaſional meditations; for he, that uſes himſelf to take notice of the properties and circumſtances of moſt things that occur to him, and to reflect on many of them, and thereby obſerves the relations of things to one another, and conſequently diſcerns, how the properties or circumſtances of one may be accommodated, by way of reſemblance or diſſimilitude, to ſomewhat that relates to the other, will often find, beſides thoſe things which afford him his occaſional reflection, divers others, which, though leſs fit for the meditation, that invited his taking notice of them, may be very fitly applicable to other ſubjects and purpoſes, and will eaſily furniſh him with reſemblances, wherewith he may, if he pleaſes, much increaſe the books of ſimilitudes, already extant. And the compariſons, that may be this way lighted on, may ſometimes prove ſtrange, and unobvious enough, to be ſurpriſing even to himſelf, as well as to his auditors, or his readers.

## CHAP. V.

BUT, beſides thoſe ſimilitudes we may be furniſhed with by the things we obſerve, without turning them into occaſional meditations, we may find in thoſe very ſubjects, whereon we do make reflections, circumſtances, that, though improper, or at leaſt unneceſſary, to be taken into the occaſional meditation, may be very fitly accommodated to other things, and plentifully contribute to the ſtore and variety of compariſons we lately mentioned. This muſt appear ſo much a truth, to any that is exerciſed in making occaſional reflections, that I ſhould perhaps forbear to illuſtrate it, by any particular example, but that this part of my diſcourſe recalls into my mind ſome thoughts, that were ſuggeſted to me by one of the laſt occaſions I had, to make reflections of this nature. I ſhall add then, that being all alone, and diverted a pretty while by a ſudden ſtorm of thunder, lightning, wind, and rain, from the imployments I had deſigned my ſelf to, I had the unwelcome leiſure to make ſome reflections upon the rude objects, that obtruded themſelves upon my obſervation.

AND the chief thing, that preſented itſelf to my thoughts, was a reſemblance betwixt prophane or atheiſtical wits, and the black clouds that then over-caſt the ſky: for, as thoſe clouds are raiſed to an elevated ſtation, and do afford flaſhes of light; ſo theſe irreligious wits are oftentimes conſpicuous enough, and may bring forth notions, that are ſurpriſing, and inſtructive. But as the ſame clouds, whilſt they whereby ſome men have a readineſs and ſubtilty in conceiving things, and a quickneſs and neatneſs in expreſſing them; all which the cuſtom of ſpeaking comprehends under the name of wit; which pleaſing, and (if well managed) uſeful quality, the exerciſe I am diſcourſing of may three or four ſeveral ways promote.

For (firſt) the accuſtoming one's ſelf to make extemporal reflections, and that upon all kind of occaſions, does by degrees bring the mind to a readineſs of conception, which keeps a man from being eaſily ſurprized by the ſubject he has occaſion to conſider, and enables him oftentimes to ſurprize his hearers; and that ſuch a kind of ſurprize is one of the moſt endearing circumſtances of the productions of wit, he muſt not have much conſidered the nature of them, that ignores.

Next, the ſame exerciſe inures a man to draw his conceptions from the very nature of the thing he ſpeaks of; which, among thoſe that can judge of wit, is held a far greater ſign of it, than the ſaying things more ſpecious and elaborate, that appear to be antienter than the occaſion; as is uſual in epigrams, and other ſolemn premeditated pieces of wit, where oftentimes the thoughts were not made for the themes, but before them: whereas the ſuddenneſs of a good occaſional reflection, and its congruity to that which gave it riſe, perſuades the hearers, that the ſpeaker's wit is of its own growth, and is rather ſuggeſted by the occaſion, than barely applied to it.

A third way, whereby our Meleteticks may conduce to wit, is, by bringing thoſe, that uſe to write their thoughts, to what may be called a certain *ſuppleneſs of ſtyle*; for when a man treats of familiar, or of ſolemn ſubjects, he is ſo much aſſiſted by the received phraſes and manners of ſpeaking, that are wont to be imployed about them, that being ſeldom at a loſs for convenient expreſſions, his wit is ſeldom diſtreſſed how to furniſh him with words fit for his turn. But the ſubjects, that invite occaſional reflections, are ſo various and uncommon, and oftentimes ſo odd, that, to accommodate one's diſcourſe to them, the vulgar and received forms of ſpeech will afford him but little aſſiſtance; and to come off any thing well, he muſt exerciſe his invention, and put it upon coining various and new expreſſions, to ſuit that variety of unfamiliar ſubjects, and of occaſions, that the objects of his meditation will engage him to write of. And by this difficult exerciſe of his inventive faculty, he may by degrees ſo improve it, and, after a while, attain to ſo pliant a ſtyle, that ſcarce any thought will puzzle him to fit words to it, and he will be able to cut out expreſſions, and make them ſit cloſe to ſuch ſubjects, as a perſon unaccuſtomed to ſuch kind of compoſures would find it very difficult to write of, with any thing of propriety.

## CHAP. IV.

It remains, that I mention one way more, and that a conſiderable one, whereby the practice of occaſional reflections may contribute to the improvement of wit; and that is, by ſupplying men with ſtore and variety of good compariſons.

How great, and how acceptable, a part of wit that is, which has the advantage to be expreſſed by apt ſimilitudes, every man's own experience, if he pleaſe to conſult it, may, in ſome meaſure, inform him. And certainly, there is no one part of wit, that is ſo generally applicable to all kind of perſons; for good compariſons ſerve equally to illuſtrate, and to perſuade; the greateſt wits diſdain them not, and even ordinary wits are capable to underſtand them, and to be affected by them: and if a ſermon, or a long diſcourſe, be enriched with one apt compariſon, what part ſoever elſe be forgotten, that will be ſure to be remembred. And a but plauſible argument, dreſſed up in fine ſimilitudes, ſhall be more prevalent among the generality of men, than a demonſtration propoſed in a naked ſyllogiſm; and therefore, the ancient ſages did ſo much chuſe to imploy a figurative way of delivering their thoughts, that when they could not furniſh themſelves with reſemblances fit for their turns, they would deviſe parables, and apologues, to recommend what they ſaid to the attention and memory of thoſe they would work upon. And thoſe famous orators, who, though they lived in commonwealths, did, by their eloquence, exerciſe a more than monarchical government there, and who, by their inchanting tongues, ruled thoſe warlike people, whoſe ſwords had made them maſters of the world; thoſe imperial wits, I ſay, whoſe oratory performed ſuch wonders, performed them chiefly by the help of their happy compariſons, which alone contributed more to their ſucceſs, than almoſt all the other perſuaſive figures of their triumphant rhetorick; lucky compariſons being indeed thoſe parts of wit, that as well make the ſtrongeſt impreſſions upon the mind, as they leave the deepeſt on the memory. Now, as the being furniſhed with apt compariſons does ſo very much conduce to the making a man's diſcourſes and writings appear witty, ſo there is ſcarce any thing more fit and likely to ſupply a man with ſtore and variety of compariſons, than the cuſtom of making occaſional meditations; for he, that uſes himſelf to take notice of the properties and circumſtances of moſt things that occur to him, and to reflect on many of them, and thereby obſerves the relations of things to one another, and conſequently diſcerns, how the properties or circumſtances of one may be accommodated, by way of reſemblance or diſſimilitude, to ſomewhat that relates to the other, will often find, beſides thoſe things which afford him his occaſional reflection, divers others, which, though leſs fit for the meditation, that invited his taking notice of them, may be very fitly applicable to other ſubjects and purpoſes, and will eaſily furniſh him with reſemblances, wherewith he may, if he pleaſes, much increaſe the books of ſimilitudes, already extant. And the compariſons, that may be this way lighted on, may ſometimes prove ſtrange, and unobvious enough, to be ſurpriſing even to himſelf, as well as to his auditors, or his readers.

## CHAP. V.

BUT, beſides thoſe ſimilitudes we may be furniſhed with by the things we obſerve, without turning them into occaſional meditations, we may find in thoſe very ſubjects, whereon we do make reflections, circumſtances, that, though improper, or at leaſt unneceſſary, to be taken into the occaſional meditation, may be very fitly accommodated to other things, and plentifully contribute to the ſtore and variety of compariſons we lately mentioned. This muſt appear ſo much a truth, to any that is exerciſed in making occaſional reflections, that I ſhould perhaps forbear to illuſtrate it, by any particular example, but that this part of my diſcourſe recalls into my mind ſome thoughts, that were ſuggeſted to me by one of the laſt occaſions I had, to make reflections of this nature. I ſhall add then, that being all alone, and diverted a pretty while by a ſudden ſtorm of thunder, lightning, wind, and rain, from the imployments I had deſigned my ſelf to, I had the unwelcome leiſure to make ſome reflections upon the rude objects, that obtruded themſelves upon my obſervation.

AND the chief thing, that preſented itſelf to my thoughts, was a reſemblance betwixt prophane or atheiſtical wits, and the black clouds that then over-caſt the ſky: for, as thoſe clouds are raiſed to an elevated ſtation, and do afford flaſhes of light; ſo theſe irreligious wits are oftentimes conſpicuous enough, and may bring forth notions, that are ſurpriſing, and inſtructive. But as the ſame clouds, whilſt they give us but their own momentary light, obſcure (by darkning the ſky) and hinder us, as much as they can, from receiving that of the ſun, which reaches further, and is many other ways preferable to vaniſhing coruſcations; ſo theſe wits, whilſt they ſeem to enlighten thoſe they dazzle, with their own new opinions, do really deprive them of the true heavenly light, that would elſe ſhine forth to them in the revealed word of God. And as the light, that we do receive from the clouds, may dazzle and aſtoniſh us, but is not ſufficient for us to travel by; ſo the admired reaſonings of theſe ſophiſters may ſurprize and amaze us, but will never prove ſufficient to be, like the ſcripture, a conſtant *lamp unto our feet, and a light unto our paths.* Pſal. cxix. 105. And as the light afforded by ſuch clouds is not only wont to be attended with affrighting thunder, and hurtful ſtorms, but burns, and deſtroys, or at leaſt ſcorches, and blacks, where it paſſes, and oftentimes falls upon churches, hoſpitals, colleges, and brings ſuch frights and ruins whereſoever it comes, that it were a great deal better men wanted the light of ſuch flaſhes, than that they ſhould be expoſed to ſuch inconveniencies by them; ſo the inſolent and irregular wits, I am ſpeaking of, do not only make an unwelcome noiſe in the world, but do oftentimes ſo denigrate the reputation of them that oppoſe them, and bear ſo little reſpect even to things ſacred, or uſeful to mankind, without ſparing the church or ſeminaries of learning, if either come in their way, that they do far more miſchiefs by their errors, or their practices, than the little inſtruction they give us is able to make amends for.

This, if I forget not, was the ſubſtance of the occaſional meditation ſuggeſted to me by the ſtorm; but, beſides that, there are in this ſome particulars, which are not neceſſary to the meditation it ſelf, and may be fitly enough accommodated, by way of compariſons, to other occaſions. I remember, the ſame ſubject (the ſtorm) had other circumſtances in it, fit to afford ſimilitudes applicable to other ſubjects, and ſome of them unobvious enough. For inſtance, it is not eaſy to find ſo illuſtrious a compariſon, to ſet forth, how the moſt contrary qualities may proceed from the ſame ſubjects, as that which we may be ſupplied with, by conſidering, that from the ſame clouds we derive both light and darkneſs; and a noble compariſon of contraries, conjoined in one ſubject, may be borrowed from the ſame clouds, which afford us lightning, and rain, ſhew that they contain in them two of the eminenteſt and ſeldomeſt conſiſtent contraries of nature, fire and water. And another compariſon may be derived from the differing productions of theſe clouds, to illuſtrate thoſe things, which do at once both much good and much miſchief, or ſometimes the one, and ſometimes the other: for the ſame clouds both produce the thunder, and the lightning, and thereby blaſt trees, kill men and beaſts, fire houſes, and ruin the nobleſt buildings, without ſparing churches themſelves; and, on the other ſide, plentifully afford us thoſe refreſhing and fertilizing ſhowers, that correct the heat of the ſultry air, and cure the barrenneſs of the parched earth. And one that is ſkilled in framing compariſons out of diſſimilitudes, and exerciſed in the other ways of turning and winding of ſimiles, may eaſily enough find, in the ſubject we have been conſidering, circumſtances capable of being conveniently enough accommodated to more ſubjects and purpoſes, than I have leiſure now to take notice of. And ſince, as the being able to find the latent reſemblances betwixt things ſeemingly unlike, makes up a great part of what we are wont to call wit; ſo the being able to diſcern the unobvious diſparities of things manifeſtly reſembling is one of the chief things, that diſplays the faculty men call judgment. And ſince both theſe are very much aſſiſted by the cuſtom of making reflections, wherein we muſt take notice of the ſeveral properties, wherein things either are alike, or diſagree; methinks it ſhould not a little manifeſt the uſefulneſs of our Meleteticks towards the improvement of men's parts, that they not only inſtruct the more ſerious faculty of the ſoul, but ſharpen the more ſubtile.

## CHAP. VI.

IV. BUT the practice I have all this while been recommending, does not only diſpoſe us to attention, in obſerving the things that occur to us, and accuſtom us to reflect on them ſeriouſly, and expreſs them fitly; but does alſo, though inſenſibly, ſuggeſt to us ways and methods, whereby to make the objects we conſider informative to us.

FOR by example, analogy, or ſome of thoſe other ways, which we may be invited, on another occaſion, to inſiſt on, we are, as it were, led by the hand to the diſcovery of divers uſeful notions, eſpecially practical, which elſe we ſhould not take any notice of. And indeed the world is the great book, not ſo much of nature, as of the God of nature, which we ſhould find even crouded with inſtructive leſſons, if we had but the ſkill, and would take the pains, to extract and pick them out. The creatures are the true Ægyptian hieroglyphicks, that under the rude forms of birds, and beaſts, *&c.* conceal the myſterious ſecrets of knowledge, and of piety. And as chemiſts boaſt of their elixir, that it will turn the ignobleſt metals into gold; ſo wiſdom makes all objects, on which it operates, inrich the poſſeſſor with uſeful and precious thoughts. And ſince even the illiterate huſbandman can, with the moſt abject dung it ſelf, give a flouriſhing growth to the moſt uſeful grains, to medicinable herbs, and even to fragrant flowers; why may not a wiſe man, by the meaneſt creatures, and ſlightedeſt object, give a conſiderable improvement to the nobleſt faculties of the ſoul, and the moſt lovely qualities of the mind?

BUT the particular method of deriving inſtruction from the ſubjects we conſider will be more fit to be particularly inſiſted on, when we ſhall have more time, or ſome other opportunity, to treat of the manner of making occaſional meditations; and ſhew, how they may be fetched from example, analogy, diſſimilitude, ratiocination, and other topicks, which we muſt not now take any further notice of.

# SECT. IV.

## CHAP. I.

HITHERTO we have conſidered the benefits, that may be afforded by the practice of occaſional meditations to the *intellectual faculties*. We will now proceed to the advantages, that may accrue from the ſame practice to the *will and affections*; theſe advantages being not only the moſt valuable in themſelves, but thoſe, upon whoſe account I have been engaged in the preſent undertaking.

V. THE laſt therefore and greateſt benefit I ſhall take notice of, in the practice I would invite you to, is, that it awakens good thoughts, and excites good motions in the will and affections. For ſince we have already manifeſted, that it is wont to ſuggeſt variety of notions to the meditator, and ſuch as are uſually accompanied with delight; this friendly property to devotion, which I now aſcribe to our Meleteticks, is a very eaſy and genuine off-ſpring of the marriage of the two others: the beams of knowledge, acquired by ſuch reflections, having in them, like thoſe of the ſun, not only light, but heat. And indeed it were ſomewhat ſtrange, as well as ſad, if a perſon diſpoſed and accuſtomed to obſerve and conſider, converſing with ſuch inſtructive books as thoſe of God's creatures and his providence, with an intention to take out practical leſſons, ſhould not find them. For amidſt that rich variety of objects, that in differing manners proffer themſelves to his conſideration, and ſuggeſt to him a great diverſity of reflections, it cannot reaſonably be imagined, that he ſhould not find ſubjects or circumſtances, that are proper, either to afford him examples to imitate, or ſhew him the danger, or unhandſomeneſs, or inconvenience of ſomething that he ſhould avoid, or raiſe his thoughts and affections heaven-wards, or furniſh him with ſome new practical conſideration, or ſhew him ſome known truth in a varied and delightful dreſs, or (at leaſt) recall ſome notions his frailty makes him need to be put in mind of, or, in a word, either refreſh his memory, or otherwiſe cheriſh his devotion. Let us ſuppoſe a perſon, who being qualified and accuſtomed to reflect upon various objects that occur to him, mainly deſigns, in the exerciſe of that faculty, the warming of his affections, and the improvement of his piety; and we ſhall ſcarce doubt, but when he looks about him in the world, he will find it, what one of the fathers loftily ſtyled it, παιδευτήριον τῆς θεογνωσίας καὶ ψυχῶν λογικῶν διδασκαλίον, (a ſchool for rational ſouls to learn the knowledge of God). There is ſcarce any thing, that nature has made, or that men do or ſuffer, though the theme ſeem never ſo low and ſlight, whence the devout reflector cannot take an occaſion of an aſpiring meditation: as in a hopeful morning the humble lark can, from the loweſt furrow in the field, take a ſoaring flight towards heaven, and aſcend thitherward with a melody, that delights both herſelf and her hearers. If ſuch a perſon conſiders, how amongſt ſuch an admirable variety, and ſuch odd antipathies of the numberleſs creatures that compoſe the univerſe, the conſtant obſervation of the laws of their nature makes them univerſally, and, as it were, unanimouſly, to conſpire to make the author of it appear wonderful in it; he cannot but be willingly poſſeſſed with ſuch an awful admiration of the matchleſs wiſdom of their great diſpoſer, as made the Pſalmiſt cry out, upon a ſomewhat like occaſion, Pſal. civ. 24. * *How manifold are thy works, O Lord, how wiſely haſt thou made them all?* If he have occaſion to conſider the merciful diſpenſations of divine providence to the godly, or to take notice of the ſevere inflictions of divine juſtice on the wicked, he will find himſelf powerfully engaged to rely on the one, and to apprehend provoking the other. If he take notice, that the world is but our ſtorehouſe, and that multitudes of admirable creatures ſeem to have had a being given them, principally for the uſe of undeſerving man; inſomuch that many of the beaſts, and birds, and fiſhes, are but our caters for one another; he will burſt out into mental, if not vocal, expreſſions of thankfulneſs and humiliation to the father of mercies, for ſo unmerited and ill returned a bounty, and will be apt to ſay with Pſal. cxliv. 3. *David*, *What is man, that thou takeſt knowledge of him; or the ſon of man, that thou makeſt account of him?* And if he compare this munificence of God, in daily giving ſo many creatures, that never violate the laws of their nature, nor endeavour to diſappoint him of his ends in creating them, for the neceſſities, nay, for the pleaſures, of rebellious and unthankful man; he will reſent an ingenuous ſhame, and a noble diſdain, that that creature ſhould be of all the leaſt grateful, that has received the moſt benefits, and that he ſhould of all others prove the moſt unruly, who alone has been endowed with reaſon to rule himſelf withal. If in a ſtarry night he looks upon the firmament, and conſiders how many fixed ſtars there are, and how many thouſand times more there might be without wanting room, the leaſt of which aſtronomers teach us to be far bigger than the whole earth, which yet, by the probableſt computation, contains above ten thouſand millions of cubick German leagues, (and conſequently above threeſcore times as many *Engliſh* miles of ſolid meaſure) he will find abundant cauſe to exclaim with *David, When I conſider the heavens, the work of thy hands, the moon and ſtars which thou haſt ordained, what is man, that thou ſhouldſt be mindful of him, or the ſon of man, that thou viſiteſt him?* Pſal. viii. 3, 4.

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* So *Junius* and *Tremellius* tranſlate the place, *Quàm ampla ſunt opera tua, O Jehova, quàm ea omnia ſapienter feciſti?* and ſo the original will bear, if the Hebrew *Ma* be made applicable as well to the latter, as to the former part of the words.

## CHAP. II.

AND ſince our diſcourſe has led us to the mention of a text, where the truly inſpired poet (who, by his omitting to ſpeak of the ſun, ſeems to have compoſed this pſalm in the night) makes the moon the chief ſubject of his meditation; it will not perhaps be amiſs, if, on this occaſion, we add a few ſhort reflections on the ſame theme, and thereby confirm what we lately noted about the differing reflections and ſimilitudes, which may be afforded by the ſame ſubject, as its ſeveral attributes may be differingly conſidered.

IF then, in the firſt place, when our contemplator takes notice of the greateſt brightneſs of the moon, he remembers too, that it is when ſhe is at the full, that ſhe is ſubject to be eclipſed; it would put him in mind of the mutability of human things, and that oftentimes proſperity proves never the more ſecure for appearing the more full and reſplendent.

NEXT, our reflector may find in the moon a lively emblem of a true miniſter of the goſpel. For, as the moon communicates to the earth the light, and that only, which ſhe receives from the ſun; ſo the Apoſtles, and firſt preachers of Chriſtianity, and (in their meaſure) their true ſucceſſors, communicate to mankind the light, which themſelves have received from the bright ſun of righteouſneſs. And the ſimilitude may be advanced, by adding, that as the moon ſhines not on the earth, with any other beams than thoſe ſhe derives from that fountain of light, the ſun; ſo the true preachers of the heavenly doctrine mingle not their own inventions, or human traditions, with that pure and ſincere light of revelation they are employed to diſpenſe: it being ſafeſt, and moſt deſirable, for the church, that Chriſtians ſhould receive the bread of life, as the Jews are recorded to have received the material bread, in a paſſage of St. *Matthew*'s goſpel, where it is ſaid, that Chriſt firſt brake, and gave to the diſciples, the bread, which they afterwards, from him, diſtributed to the people; ſo that they might each of them, in a literal ſenſe, imploy that expreſſion of St. *Paul, I have received of the Lord, that which I delivered unto you.* Mat. xv. 36. 1 Cor. xi. 3.

AND as though the moon be deſtitute of native light, yet by virtue of that borrowed one, which ſhe plentifully receives from the ſun, ſhe affords more to men than any of the ſtars, which, upon the ſcore of their vaſt diſtance from the ſun, are, by modern naturaliſts, ſuppoſed to ſhine by their own light; ſo thoſe illiterate fiſhermen, whom the ſon of righteouſneſs called, and made the light of the world, did, by virtue of the copious irradiations he vouchſafed them, diffuſe far more light to mankind, than the greateſt philoſophers, that, being unaſſiſted by divine revelation, had only their own native beams to ſhine with.

AND as oftentimes the ſame ſubject, but as variouſly conſidered, may afford both ſomewhat fit to be ſhunned, and ſomewhat fit to be imitated; ſo, in that, which we ſuppoſe our reflector now conſidering, he may eaſily diſcern the emblem of an ungrateful perſon. For as the moon, though ſhe receive all the light that ennobles her from the ſun, does yet, when ſhe is admitted to the neareſt conjunction with him, eclipſe that bright planet, to which ſhe owes all her ſplendor; ſo unthankful men abuſe thoſe very favours, that ſhould endear to them their benefactors, to the prejudice of thoſe that oblige them.

AND it is like, that our reflector may, by the way, take notice, that as what paſſes betwixt the moon and the ſun, does thus afford him a ſimile, whereby to ſet forth ingratitude; ſo what paſſes betwixt the moon and the ſea may ſupply him with an example of the contrary quality, and put him in mind, that a thankful man will be true and obſequious to his benefactor, though the perſon that obliged him have loſt that proſperity, that before made him conſpicuous, and attracted vulgar eyes; as the ſea follows the courſe of the moon, not only when ſhe ſhines upon it with her full light, but when at the change ſhe can communicate little or no light to it.

To the two above-mentioned attributes, upon whoſe account the moon afforded a compariſon for human proſperity, and another for preachers of the Goſpel, we will now add, that ſhe may afford us a ſimilitude to ſet forth a liberal perſon by; for as the moon freely communicates to the earth the light ſhe receives from the ſun, ſo the bountiful perſon imparts to indigent men the largeſſes he receives from the exuberant goodneſs of God. And as to intellectual communications, the parallel will hold further, ſince as the moon enjoys not the leſs light, for her imparting ſo much to the earth; ſo in mental communications liberality does not impoveriſh, and thoſe excellent gifts ceaſe not to be poſſeſſed by being imparted. And it is very poſſible, (to add that upon the bye) that after the light of the moon has (according to what I lately noted) repreſented to our contemplator the qualifications of a preacher, it may alſo put him in mind of the duty of a hearer. For, as it were very fooliſh in us, and unthankful towards the father of lights, not to make uſe of the great light we receive from the ſun by the moon, or not to acknowledge the moon to be a very uſeful creature, upon the ſcore of that light, wherewith ſhe ſhines upon the earth, though, in her, that light be deſtitute of heat; ſo it were unwiſe and ungrateful for hearers to refuſe to acknowledge, or to be guided by, the conſpicuous endowments of learning and eloquence, that God vouchſafes to great ſcholars, though they themſelves were but illuſtrated, not warmed by the beams they reflect. But therefore, as oyſters, and other ſhell-fiſh, are obſerved to thrive at the increaſe of the moon, though her light be unattended with heat, and though even when ſhe is at full, ſhe wants not her ſpots; ſo devout hearers will be careful to proſper proportionably to the inſtructions they receive even from thoſe preachers, whoſe illuminations are unaccompanied with zeal and charity, and who, when they ſhine with the greateſt luſtre, are not free from their darkneſſes, as to ſome points, or from notorious blemiſhes.

AND as the moon may thus furniſh our contemplator with ſimilitudes, to ſet forth both a virtue and a vice of the mind, ſo may it ſupply him with an emblem of its condition; for as the light of the moon is ſometimes increaſing, and ſometimes in the wane, and not only is ſometimes totally eclipſed, but even when ſhe is at the full, is never free from dark ſpots; ſo the mind of man, nay, even of a Chriſtian, is but partly enlightened, and partly in the dark, and is ſometimes more, and ſometimes leſs, illuſtrated by the beams of heavenly light, and joy; and not alone now and then quite eclipſed by diſconſolate deſertions, but even when it receives the moſt light, and ſhines the brighteſt, knows but in part, and is in part blemiſhed by its native darkneſſes, and imperfections. And theſe reſemblances are not ſo appropriated to the mind of man, but that they might eaſily be ſhewn to be applicable to his condition, in point of outward proſperity, and adverſity. And to theſe reſemblances other reflections on the ſeveral adjuncts of the moon might be alſo added, together with ſeveral examples of this nature on other ſubjects, were it not, that I think my ſelf to have ſpent time enough already upon a theme, that fell but incidentally under my conſideration; and were it not alſo, that the reflections, which might here be annexed upon the attributes of other objects, may be more properly ſubjoined to what may be on another occaſion preſented to you, by way of illuſtration of ſome particulars, that belong to the fourth part of the precedent ſection, in which my haſte, and ſome other reaſons, made me content my ſelf, to give ſome few general hints about ſuch reflections, and an intimation of the topicks, whence I am wont to fetch them.

## CHAP. III.

And having given you this advertiſement, *en paſſant*, we may now proceed a little further, and add, that if we ſuppoſe our contemplator's thoughts to deſcend from heaven to earth, the far greater multitude and variety of objects, they will meet with here below, will ſuggeſt to them much more numerous reflections. But becauſe ſo ſpacious a field for meditation as the whole earth would afford to us too vaſt a theme to be attempted on this occaſion, we will confine our contemplator to his garden, or rather to any one of the trees of it, and take notice, not of all the meditations he might fetch thence, but only of four or five of the conſiderableſt of thoſe, that the viewing it may, as he walks by at ſeveral times, ſupply him with.

If then, in the ſpring of the year, our reflector ſees the gardener pruning a fruit-tree, we may ſuppoſe him invited by that object, to reaſon thus within himſelf: Though one, that were a ſtranger to the art of gardening, would think, that that man is an enemy to this tree, and goes about to deſtroy it, ſince he falls upon and wounds it, with a ſharp iron, and ſtrikes off ſeveral of its youthful parts, as if he meant to cut it in pieces; yet he that knows, that the gardener's arm is not ſet on work by anger, but by ſkill, will not conclude, that he hates the tree he thus wounds, but that he has a mind to have it fruitful, and judges theſe harſh means the fitteſt to produce that deſirable effect. And thus, whatever a man, unacquainted with the ways and deſigns of providence may ſurmiſe, when he ſees the church not only expoſed to the common afflictions of human ſocieties, (for that is but like our tree's being expoſed to be weather-beaten by winds, and rain) but diſtreſſed by ſuch perſecutions, as ſeem to be divine inflictions, that invite men to ſay of the body, what the prophet foretold ſhould be ſaid of the head, *We eſteemed him ſtricken,* Iſaiah liii. *ſmitten of God, and afflicted:* 4. whatever, I ſay, a carnal, or a moral, man would be apt to imagine, upon ſight of the church's diſtreſſes, the knowing Chriſtian will not from thence infer, that God hates her, or that he has abandoned her; ſince it is he, that loved his church ſo well, as to give himſelf for it, who declares, that as many as he loves, he rebukes and chaſtens. And this is ſo fitly applicable alſo to particular believers, that the divine ſon of the great * *γεοργὸς* does not only give us cauſe to John xv. think, that afflictions do not ſuppoſe God's hate, but to hope that they may not 2. always ſuppoſe man's guilt, but ſometimes rather aim at his improvement; ſince they are the memorable words of our Saviour, ſpeaking of his Father, *Every branch in me,* John xv. *that beareth not fruit, he taketh away, and every branch that beareth fruit, he purgeth it,* 2. *that it may bring forth more fruit.* And it may ſomewhat illuſtrate the ſimilitude to add, that the huſbandman uſes only to prune the trees of his garden, not thoſe that grow wild in his woods; but though he oftner wound theſe, yet he wounds the other more fatally, imploying but the pruning hook to pare off the ſuperfluous twigs, or at moſt, branches, of the one, whilſt he lays the ax to the root of the other, to fell the tree it ſelf.

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* That is, Cultivator of the ground.

BUT theſe are not the only thoughts, which the pruning of a fruit-tree may ſuggeſt to our reflector: for if he conſiders, that by cutting off ſeveral of the parts of the tree, and by nailing many of the reſt to the wall, the gardener does not only ſecure the tree from being blown down, or torn, by the rudeneſs of boiſterous winds, but makes it look well ſhaped; ſo the divine huſbandman, (as we have lately ſeen God ſtyled in the ſcripture) by the wiſe, and ſeaſonable, though ſeemingly rigorous, and uſually unwelcome, culture, he imploys upon thoſe children of his, whom he afflicts, does not only protect them from ſeveral dangers, whereto, without thoſe harſh reſtraints, they would be expoſed; but as he makes them amends in point of ſafety for what he denies them in point of liberty, ſo he adorns them by wounding them; his kind and ſkilful ſtrokes adding as much to the beauty of a Chriſtian's mind, as they cut away from the ſuperfluities of his fortune; for the preſſures of affliction do give ſuch ſmoothneſs and gloſs to the ſoul, that bears them patiently and reſignedly, that the heathen moraliſt ventured to ſay, that if there were any ſpectacle here below noble enough, and worthy to entertain the eyes of God, it was that of a good man, generouſly contending with ill fortune. And the hyperbole (though after this manner ſomewhat loftily expreſſed) will appear the leſs ſtrange to him, that conſiders that *Job* had not only his patience, when it had been tried to the uttermoſt, crowned with a fortune double to that, which had been the faireſt in the Eaſt; but before his conſtancy was tried near ſo far, received that much higher recompence of an honour never vouchſafed to mortals until then, when God himſelf did not only approve, but
Job ii. 3. (if I may ſo ſpeak with reverence) make his boaſt of, a man: *Haſt thou conſidered* (ſays he to man's great enemy) *my ſervant* Job, *that there is none like him in the earth, a perfect, and an upright man, one that feareth God, and eſcheweth evil? and ſtill he holdeth faſt his integrity, although thou movedſt me againſt him to deſtroy him without a cauſe.* Sure one may call him more than happy *Job*, ſince, if, as *David* tells us, the
Pſ. xxxii. 1. *man is happy, whoſe ſins God is pleaſed to cover*; what may that man be accounted, whoſe graces he vouchſafes to proclaim?

## CHAP. IV.

AND as the conſideration of the pruning of trees, under the notion of *that which wounds them*, may afford our contemplator the reflections already pointed at; ſo the conſidering of the ſame action, under another notion, may lead him to reflections of another nature: for if he obſerves, that, in certain caſes, gardeners oftentimes do not only prune away all the ſuckers, and many of the luxuriant ſprigs, but cut off ſome of the branches themſelves, provided they ſpare the maſter-boughs; and yet theſe amputations, though they take much from the tree, are deſigned to add to the fruit, as accordingly they are wont to do: if, I ſay, our reflector takes notice of this, it may eaſily ſupply him with an illuſtration of what he may have obſerved among ſome men, who, by afflictions, even in point of fortune, are brought to be far more charitable, than they would have been, if their peace and plenty had continued unimpaired. As, beſides that St. *Paul*, ſpeaking of the *Macedonian* churches, gives them
2 Cor. viii. 2. this character, *That in a great trial of affliction, the abundance of their joy, and their deep poverty, abounded unto the riches of their liberality*; we have in *Zaccheus* a memorable inſtance to our preſent purpoſe, ſince, after his repentance had, by his own conſent, cut off from his eſtate more than all that ſlander, oppreſſion, and other unjuſt ways of getting, (which uſed to bring in but too great a part of a publican's)

had added to it; he gave away more, out of the remainder of his eſtate, than every liberal man would have done out of the whole. His wealth, like a ſkilfully pruned tree, bore the more fruit to piety, for having had ſome parts of it cut away; he grew rich (in good works) by being deſpoiled, and his charity increaſed as much as his fortune was leſſened.

IF, towards the end of the ſpring, our reflector ſee the ground under his tree ſtrowed with the bloſſoms, that time and winds may have caſt down thence, it is like it would furniſh him with this conſideration; That, as though the bloſſoms are in themſelves great ornaments to a tree, and oftentimes both uſeful and pleaſant things, yet to be ſeaſonably deprived of them, is not a miſchief to the tree that loſes them; ſince, till the bloſſoms are gone, the fruit, which is a better and more laſting thing, and more principally intended by nature, cannot be had: ſo it will not always follow that becauſe certain things are in their kind deſirable, and therefore may be reckoned among goods, the loſs or depravation of them muſt neceſſarily be an evil. And ſo, though a fair and healthy body may be looked upon as a bleſſing, yet it will not follow, that a *death* (as the Scripture ſpeaks) either *in* or *for the Lord*, becauſe it throws this flouriſhing body to the ground, and makes it rot there, muſt needs be a deplorable evil: ſince, as the bloſſoms falling off, is, according to the courſe of nature, neceſſarily previous to the formation, or, at leaſt, the perfection, of the fruit; ſo the being deprived of this life is, according to God's ordination, a neceſſary antecedent to our being enriched with thoſe more ſolid and durable bleſſings of perfect virtue and happineſs.

Οἱ ἐν Κυρίῳ ἀποθνήσκοντες. Rev. xiv. 13.

AND if, whilſt our contemplator's tree is adorned with leaves, as well as bloſſoms, (as we often ſee ſeveral of the former come before all the latter are gone) he chance to take notice, how buſy the bees are in ſucking theſe, whilſt they leave the others untouched, he may peradventure make this, or ſome ſuch other reflection on it: That, though the leaves be not only ornaments of a tree, but productions, often uſeful to ſhade and ſhelter the fruit, and are of a more ſolid texture, and a more durable nature than the bloſſoms, which ſeem to be of a ſlighter make, and rather gawdy and delightful than laſting; yet it is not about the leaves, but the bloſſoms, that the induſtrious bee aſſiduouſly imploys her time, as ſucking from thoſe gaudy productions of the tree ſtore of that honey, which the leaves would not afford her.

THUS, though the books written about dogmatical and controverſial points in divinity, may be in their kind valuable, and uſeful productions of ſkill in theology, and may ſeem more ſtrong and ſubſtantial compoſures, and likely to retain their reputations longer, than books of devotion; yet it is of theſe, rather than thoſe, that the devout Chriſtian will be a ſolicitous peruſer; ſince it is not from barren, though ſolid aſſertions or diſputes, but from florid and pathetical books of devotion, which firſt allure the reader, and then affect him, that the devout ſoul extracts her honey, I mean, thoſe celeſtial pleaſures, that reſult from, as well as maintain, a free communion with God, which does at once both exerciſe her devotion, and recompenſe it, and afford her, as flowers do the bee, an aliment equally nutritive and delicious.

AND he may ſomewhat illuſtrate, as well as continue, the alluſion further, by conſidering, that ſilk-worms, that live upon leaves, and bees, that feed on flowers and bloſſoms, do indeed both of them thrive upon their reſpective aliments, and are thereby enabled to preſent men with uſeful productions, but with this difference; that the ſubtile threads of ſilkworms ſerve principally to cloath others, whereas the honey, that is elaborated by the bee, does not only ſupply others with a healing and cleanſing

ſing medicine in ſome diſtempers, but affords a great deal of pleaſure to the bee herſelf: for thus, though as well the diligent ſtudiers of ſpeculative and polemical divinity, as the careful peruſers of books of devotion, may be advantaged by what they ſtudy, yet this difference may be obſerved betwixt them, that the former may, by the diſcourſes they read, be aſſiſted to write others of the like nature, whereby their readers may be enabled to talk with more acuteneſs, and applauſe; but the latter may not only be aſſiſted by making ſuch compoſures, as they aſſiduouſly converſe with, to contribute to the cleanſing of men's conſciences from dead works, and as well pacify the troubles of their minds, as heal the wounds, which ſchiſm or ſcandal may have given to the church; but do often, in the firſt place, feel themſelves all the joys, and advantages, they would procure to others, and they happily find pious reflections, devout ſoliloquies, ardent ejaculations, and other mental entertainments of a religious ſoul, to be of a nature not only ſo ſweet, but ſo improving, and ſo advantageous, that whilſt many other laudable imployments recommend us to the ſtudents of theology, theſe more eſpecially recommend us to the Author of it, and indear us to God himſelf.

If, when our fruit-tree has changed its white livery for a green, our conſiderer chance to take notice, how thick it is ſet with leaves, of which it had not one ſome months before, it may poſſibly put him in mind of the inſtability of their condition, that are undeſervedly envied for a numerous train of ſuch ſeeming friends, and gaudy attendants, as are ſo to the fortune, rather than the perſon: for, as in the ſun-ſhiny months of ſummer, when the fair weather would keep the tree warm enough, without the help of leaves, it is wont to be covered with thoſe verdant ornaments; but loſes them all in winter, when it needs their ſhelter from the rigors of that cold ſeaſon: ſo thoſe, that during the ſun-ſhine of proſperity, are beſet with ſeeming friends, of which they had no need, find themſelves left naked, and forſaken of them all, when adverſity would make their company of ſome advantage. If our contemplator chance to obſerve, how his tree flouriſhes with verdant leaves, and gaudy bloſſoms, at that ſeaſon of the year, when it is providing to bring forth fruit, it may put him in mind of the pleaſedneſs and alacrity, with which a charitable perſon ſhould ſet himſelf to the doing of good; and mind him, that as the God of nature loves a chearful giver, ſo the temper of a liberal perſon is pointed out by nature her ſelf in a tree, which ſeems to triumph in all the ornaments it can put on, when it is about to exhauſt the greateſt part of its own ſtock of ſap, to produce fruits, which only others are to eat.

If he take notice of the order, wherein it is uſual for the leaves and bloſſoms to precede the fruit, it may poſſibly invite him to look with a more favourable eye upon the green and immature eſſays of early writers, if they diſcover, that the author aims at good things, though he does not yet perform great ones: for, however theſe youthful productions of the pen are commonly rather pleaſing and florid, than otherwiſe conſiderable; yet if they be good for their ſeaſon, and in their kind, though that kind itſelf be not of the uſefulleſt, they may deſerve pardon, and perhaps encouragement; ſince, though they be not yet ſolid, they may promiſe ſomething that will be ſo; and even the beſt trees preſent us their bloſſoms, before they give us their fruit.

If the ſame contemplator happens to ſee young people firſt ſhake the tree in vain, then climb it to gather unripe fruit, it may afford him a repreſentation of men's over-eager and untimely perſuits of ſeveral deſirable things, and eſpecially of honour: for, as green fruit, though of a good kind, will not eaſily be ſhaken down by them, that would gather it, but reduces them either to climb the tree or forcibly ſtrike it off, which commonly bruiſes, and diſfigures what it procures; and as the fruit, when thus obtained, is but ſour, and unwholſome, being neither ſweetened, nor concocted, by maturity; ſo that it uſually both ſets the teeth on edge, and breeds ſickneſs in the body; whereas, if the ſame fruit were let alone till it were fully ripe, and in ſeaſon, it would both readily drop into the eater's mouth, and prove delicious, and more wholeſome food: ſo, when we greedily purſue after honour, and pleaſure, of which this life is not the proper ſeaſon, we not only meet with difficulties in acquiring them, but find not, in poſſeſſing them, either that ſatisfaction, or that advantage, that the eagerneſs of our unruly appetites promiſes us; whereas, if we would ſtay contentedly till God's time be come (which is always the beſt, and fitteſt) we ſhould not ſteal, or force, but receive unfading honours, and uncloying delights, by being preſented with *incorruptible crowns of glory*, by him, *with whom there is fulneſs of joy, and at whoſe right hand* (the ſtation deſigned for thoſe, that overcome the world's allurements, and their own impatience) *there are pleaſures for evermore*; that is, eternal ones.

1 Pet. v. 4.
Pſal. xvi. 11.

LASTLY, if towards the end of ſummer, or of autumn, our reflector, coming to viſit his inſtructive tree, find it preſent him ſtore of fruit, and perhaps obſerve it to be grown taller ſince the laſt winter, each bough will afford him a lively emblem of a true believer. For, as the loaded branch makes uſe of the moiſture it attracts from the dirty ground, to recede as much as it can from the earth, and ſpends its ſap in ſhooting up towards heaven, and bearing fruit for men; ſo the devout Chriſtian improves the bleſſings he receives of this inferior world, to elevate his mind above it; and the uſe, that he makes of earthly goods, and advantages, is to raiſe his grateful ſoul nearer to God, and diſpenſe them by works of charity to men.

## CHAP. V.

THESE, *Sophronia*, are ſome, and but ſome, of the thoughts, which the occaſional conſideration of a fruit-tree might ſuggeſt to a conſidering perſon. And if we ſhould lead our reflector from the garden to the woods, or to the river-ſide, or into the fields, or to the ſtreet, or to a library, or to the exchange; or, in a word, to I know not how many other places I could name, I have ſome reaſon to think, that each of them would ſupply him with variety of occaſional meditations. Wherefore, ſince the want of themes will not, it is fit that ſomewhat elſe ſhould, place bounds to this diſcourſe. And ſince by finding, that I myſelf begin to be weary of writing, I have too much cauſe to fear, that you are quite tired with reading, I think it high time to haſten to a concluſion: only, before I make one, I muſt do our Meleteticks the right to advertiſe you, that you would do them wrong, if you ſhould imagine, that in the paſſed diſcourſe I have either carefully enumerated, or fully diſplayed, the advantages, which a devout and ingenious contemplator may derive from the exerciſe of the ways of thinking I have been treating of. For, though I have in the paſt diſcourſe, eſpecially thoſe parts of it, that are contained in the third precedent, and in this preſent fourth ſection, ſaid enough to recommend the ſubject to any that is not much indiſpoſed to be prevailed with; yet I will not deny, but that, even in thoſe two ſections, I have left much unſaid.

FOR, beſides the ſeveral advantages and ways of making occaſional meditations already pointed at, there are other accounts, upon which the practice I would perſuade may both benefit a pious ſoul, and be made uſe of by an ingenious one. For the reſpects one thing may have to another are ſo numberleſs, and the mind of a rational man, verſed in meditations, may compound and diſjoin notions ſo many ways, and may make ſuch inferences from them, and ſuch applications of them, that it frequently happens, that beſides the reflection, ſuggeſted by that which gave the firſt riſe to his meditations, he lights upon conceits differing enough from them, and perhaps better than they: as when hounds, hunting a hare, meet in their way with a ſtag. For, though philoſophers ſeem to have juſtly enough rejected the opinion, attributed to *Plato*, *that all knowledge is but reminiſcence*; yet certainly the mind of a man, well furniſhed with variety of notions, is, by the analogy or contrariety of things and notions, in reference to each other, ſo eaſily and readily excited to lay them together, and diſcourſe upon them, that he is oftentimes by any ſlight occaſion helped to light (and that with a ſtrange and ſurprizing facility) upon things, that he would elſe have ſcarce taken the leaſt notice of. When the mind is once ſet on work, though the occaſion adminiſtered the firſt thoughts, yet thoſe thoughts themſelves may, as well as the object that excited them, become the themes of further meditation: and the connection of thoughts within the mind may be, and frequently is, ſo latent, and ſo ſtrange, that the meditator will oftentimes admire to ſee, how far the notions he is at length led to, are removed from thoſe, which the firſt riſe of his meditation ſuggeſted. And by theſe incidental excurſions he may ſometimes be as much delighted and ſurpriſed, as *Sampſon* was, when going aſide to look upon the carcaſe of a lion, he met with a ſtock of honey.

Judges xiv. 8.

BUT I can add one thing towards the inducing you to exerciſe your ſelf in the way of thinking we have all this while been ſpeaking of; which though I had almoſt forgot to take notice of, it will, I doubt not, ſeem important to *Sophronia*, to whom it need not be a diſcouragement from aiming at one of the nobleſt uſes of occaſional reflections, that it ſuppoſes not a bare acquaintance with them, but ſprings from an entire, and (if I may ſo ſpeak) intimate familiarity with our Meleteticks. For this uſe of occaſional meditations, though it do but gradually differ from ſome of thoſe, that have been already mentioned, will perhaps by the devout (and conſequently by *Sophronia*) be eſteemed the higheſt advantage, that this way of thinking can confer; and it is, that the cuſtom of making occaſional reflections may inſenſibly, and by unperceived degrees, work the ſoul to a certain frame, or temper, which may not improperly be called heavenly-mindedneſs, whereby ſhe acquires an aptitude and diſpoſition to make pious reflections upon almoſt every occurrence, and oftentimes without particularly deſigning it. But as this privilege will, as I was intimating, ſcarce fall to the ſhare of any but thoſe, that, by long or frequent exerciſe, have ſo accuſtomed their minds to reflect upon what they ſee, that they continue that practice, as it were, of their own accord; ſo when once, by ſuch a conſtant kindneſs and hoſpitableneſs to ſuch thoughts, that they will, as it were, come to the mind without calling, and make themſelves its gueſts, without particular invitations, the ſoul has attained that deſirable frame we lately called heavenly-mindedneſs, which is a diſpoſition and a readineſs to make ſpiritual uſes of earthly things, both the advantage and the delight of that frame of heart cannot but be extraordinary. It muſt ſurely afford a great deal of ſatisfaction to an ingenious and devout perſon, to be able to make the world both his library and his oratory; and which way ſoever he turns his eyes (not only upon unobvious things, but even upon the moſt familiar ones) to behold ſomething that inſtructs, or that delights him; and to find, that almoſt every object, that preſents it ſelf to his notice, preſents alſo good thoughts to his mind, to be gathered with as much innocency and pleaſure, and with as little prejudice to the things, that afford them, as honey is gathered by the induſtrious bee from the differing flowers ſhe meets with in her way. Certainly, if we would carefully lay hold on, and duly manage, this help, it would prove a powerful remedy to prevent or cure much of that dullneſs and drouſineſs, that do ſo frequently ſmother or blemiſh our devotion. There would ſcarce any thing paſs us, out of which we would not ſtrike ſome ſpark or other of that heavenly fire, or that would not contribute ſomething, either to kindle it, or to feed it, or to revive it. If but half the precious time we impertinently trifle, or ſquander away upon employments, that will be ſure to coſt us either tears or bluſhes, were carefully laid out in the cultivating of this kind of thoughts, it might often ſave our miniſters the labour of inſiſting ſo long upon the uſes of their doctrines, when the whole world would be a pulpit, every creature turn a preacher, and almoſt every accident ſuggeſt an uſe of inſtruction, reproof, or exhortation. No burial but would toll a paſſing-bell, to put us in mind of our mortality: no feaſt but would make us aſpire to the marriage-feaſt of the lamb: no croſs but would add to our deſires to be diſſolved, and to be with Chriſt: no mercy but would be a freſh engagement unto obedience to ſo good a maſter, as the author of it: no happineſs of others, but would prove an encouragement to ſerve him, that can give that, and much greater: no miſery of others, but would awake and heighten our gratitude, that we are privileged from it: no ſin in our neighbours, that would not diſſuade us from what we ſee looked ſo unhandſomely in others: nor any virtue of theirs, but would excite our emulation, and ſpur us on to imitate or ſurpaſs it. In a word, when the devout ſoul is come to make that true uſe of the creatures, as to look upon them as men do upon water, that the ſun gilds with his beams, that is, not ſo much for it ſelf as for the reflective virtue it has to repreſent a more glorious object; and when ſhe has, by long practice, accuſtomed her ſelf to ſpiritualize all the objects and accidents that occur to her, I ſee not why that practice may not be one of the moſt effectual means for making good that magnificent aſſertion of the Apoſtle, That *all things work together for good to them that love God*: a devout occaſional meditation, from how low a theme ſoever it takes its riſe, being like *Jacob*'s ladder, whereof though *the foot leaned on the earth, the top reached up to heaven.*

Rom. viii. 28.

Gen. xxviii. 12.

# OCCASIONAL

# REFLECTIONS.

## SECT. I.

### REFLECTION I.

*Upon his manner of giving meat to his dog.*

IGNORANTLY thankful creature, thou beggeſt in ſuch a way, that by what would appear an antedated gratitude, if it were not a deſignleſs action, the manner of thy petitioning before-hand, rewards the grant of thy requeſt; thy addreſſes and recompence being ſo made and ordered, that the meat I caſt thee may very well feed religion in me. For, but obſerve this dog, I hold him out meat, and my inviting voice loudly encourages and invites him to take it: it is held indeed higher than he can leap; and yet, if he leap not at it, I do not give it him; but if he do, I let it fall half way into his mouth. Not unreſemblingly deals God with us; he ſhews and holds forth to us (the ſoul's true aliment) eternal glory, and his moſt gracious word ſummons and animates us to attempt it. Alas! it is far above the reach of our endeavours, and our deſerts; and yet if we aſpire not to it, and ſtrive not for it, in vain do we expect it; but if we faithfully do what in us lies, and our endeavours ſtrain themſelves to their utmoſt, God mercifully allows the will for the effect, meaſures our performances by what they aimed at, and favourably accepting what we can do, for what we ſhould do, he ſupplies the imperfections of our faint, but yet aſpiring attempts, by ſtooping condeſcenſions; and what our endeavours want of reaching up to, his grace and acceptation brings down. Piety is the condition, though not the price, of heaven; and (like the wedding garment in the parable) though it give us not a right to the beatifick feaſt, is yet that, without which none ſhall be admitted as a duly qualified gueſt: for though we cannot reach heaven by our good works, we ſhall not obtain it without them.

## REFLECTION II.

### *Upon his diſtilling ſpirit of roſes in a limbick.*

ONE, that knew how well I love the ſcent of roſes, and were ignorant of the uſes of this way of diſtillation, would, queſtionleſs, think me very ill adviſed, thus haſtily to deprive my ſelf of the flowers I moſt love, and employ art to make them wither ſooner than nature would condemn them to do: but thoſe that know, both the fading condition of flowers, (which, unimproved by art, delight but whilſt they are, what they cannot long be, freſh) and the exalting efficacy of this kind of diſtillation, will think this artificial way, that chymiſts take, of ſpoiling them, is an effect as well of their providence as their ſkill: for that pleaſing and ſprightly ſcent, that makes the roſe ſo welcome to us, is as ſhort-lived and periſhing, as the flower, that harbours it, is fading; and though my limbick ſhould not, yet a few days inevitably would, make all theſe roſes wither. But by this way of ordering my roſes, though I cannot preſerve them, I can preſerve that ſpirituous and ætherial part of them, for whoſe ſake it is, that I ſo much prize and cheriſh this ſort of flowers; which, by this means, I preſerve, not indeed in the fading body, but in the nobler and abſtracted quinteſſence; which purer and laſtinger portion of them will be more highly fragrant than ordinary roſes are wont to be, even whilſt they are freſh, in that ſeaſon, when thoſe flowers, that have not been thus early and purpoſely deſtroyed, will, according to the courſe of nature, whereto they are left, wither and putrify.

THUS he that ſees a charitable perſon liberally part with that money, which others are ſo fond of, if he be a ſtranger to the operations of faith, and the promiſes of the goſpel, he will be apt to miſtake the Chriſtian's liberality for folly, or profuſion, and to think that he is fallen out with his money: but he that remembers, how clear a proſpect, and how abſolute a diſpoſal of the future, the Scripture of truth (to uſe an angel's expreſſion) aſcribes to him, that bid his diſciples *make themſelves friends with the uncertain (or unfaithful) mammon*, (for ſo the uſe I ſometimes meet with of the Greek word, together with the context, invites me to render it) *that when he fail, they may receive us into everlaſting habitations*; and he that ſhall likewiſe conſider, not only the tranſitory nature of worldly poſſeſſions, (from which their periſhing, or ours, will be ſure ere long to divorce us) but the ineſtimable advantage, with which we ſhall receive in heaven whatever we employ in pious uſes here on earth, will conclude this way of parting with our wealth the ſureſt and gainfulleſt way of preſerving it; ſince the Chriſtian, by parting but with what (however) he could not long keep, ſhall, through God's munificent goodneſs, obtain a much more valuable treaſure, that he ſhall never loſe: ſo that thus to ſacrifice wealth to charity is not an early loſs of it, but the right way of ſecuring it; for by this gainful way, when we ſhall, in another world, be paſt the poſſibility of poſſeſſing our riches in kind, ſuch an employment of them may help us to enjoy them, though not in the capacity of riches, yet in that noble capacity of goods, under which notion alone they are deſireable; and thus laid up they may there procure us, what they could never here afford us, happineſs.

## REFLECTION III.

*Upon his being in great danger wandering, on* Mendip *hills, among covered lead mines, that he knew not of.*

HOW have I travelled all this while upon the brink of the grave! I thought only to be out of my way, but little dreamed to be ſo near the end of all my journeys, in that of my life by traverſing to and fro amongſt thoſe deep and covered pits, upon any one of which if my horſe had but chanced to ſtumble, (and the very mine-men I at length met with, think it a kind of miracle he did not) I had been killed and buried at once, and my fate had been for ever as much concealed from my friends as my body: and all this eſcape a work ſo totally of God's goodneſs, that I did not ſo much as know my danger till I was paſt it; ſo that it ſeemed ſent, but to give me occaſion of rejoicing in my deliverance. How vaſt a debt of gratitude then do I owe to God? and how extremely do I fall ſhort of acquitting my ſelf of it? ſince, beſides that I make him but very unſuitable returns for the bleſſings I know I have received, I receive from him ſignal bleſſings, that I do not ſo much as know of, and which conſequently I am very unlike particularly to acknowledge. But this gracious reſcue, from ſo great and unexpected a hazard, ſhall, I hope, teach me henceforth to beware, both of ſecurity, ſince I often fall into dangers that I know not, and of diſtruſts of God's providence, ſince I have found it ſo watchful to deliver me from thoſe that I feared not.

## REFLECTION IV.

*His horſe ſtumbling in a very fair way.*

HERE is a patch of way, to which any leſs ſmooth than a bowling-green were rugged, and in which it ſeems not only ſo unlikely, but ſo difficult, for a horſe to trip, that nothing could have made me believe a horſe could have ſtumbled here, but that mine has dangerouſly done ſo. This jade has this very evening carried me ſafely through ways, where ſtumbles were ſo much to be expected, that they were to have been forgiven; and now in a place ſo ſmooth, that ſure he could not faulter in it, only out of curioſity and trial, he falls under me ſo lubberly, that I as much admired my eſcape as danger. But it is too uſual with us, unfaultering to traverſe adverſity's rough ways, and ſtumble in proſperity's ſmootheſt paths. The obſervation is almoſt as old as proſperity, that fortune ruins more perſons whilſt ſhe embraces them, than whilſt ſhe would cruſh them: but though the obſervation be very common, it is not more ſo, than it is to ſee even thoſe, that make it, add to the inſtances that juſtify it. I have ſeldom yet been ſo fortunate, as to be obnoxious to that leſs frequently pitied than diſarming danger: Fortune has ſeldom yet vouchſafed to turn Syren to pervert me; and ſhe has hitherto given me much more exerciſe for my conſtancy than for my moderation. I think too, that without ſlandering my ſelf, I may confeſs, that I have ſometimes wiſhed my ſelf in the liſts with that bewitching enemy, proſperity; and increaſed the number of thoſe many, who never think ſo fair an adverſary formidable, till they find themſelves vanquiſhed by her: but upon ſecond thoughts, I judge it better, to leave the choice of my antagoniſt to him, who not only beſt knows my ſtrength, but gives it me; eſpecially, when I conſider, that as we are all of us naturally ſuch ſtumblers, that (as *Solomon* ſpeaks in ſomewhat another ſenſe) *even the juſt man falls ſeven times a day*, ſo it is obſerved in ſtumblers, that they are moſt ſo in fair way; into which if providence lead my ſteps, I ſhall think it ſeaſonable to pray, *and lead us not into temptation*; and ſhall not think it unſeaſonable to remember, that ice is at once the ſmootheſt and the ſlippereſt of ways, and that (the jadiſhneſs of our natures well conſidered) there is no way, wherein we ought to travel with more heed, than that, whoſe treacherous evenneſs would divert us from taking heed to our way.

Prov. xxiv. 16.

## REFLECTION V.

*Upon two very miſerable beggars, begging together by the high-way.*

BEHOLD this fore-moſt wretch, whoſe ſtrange deformity and ghaſtly ſores equally exact our pity and our horror; he ſeems ſo fit an object for compaſſion, that not to exerciſe it towards him can ſcarce proceed from any other cauſe than the not having any at all: the ſadneſs of his condition is augmented by his want of eyes to ſee it; and his miſery is ſuch, that it calls for an increaſe of pity, by his being ſo diſtracted, as to deſire a longer life, or rather longer death: he ſues more movingly to the eye than to the ear; and does petition much leſs by what he ſays, than what he is: each ſeveral member of his tortured body is a new motive to compaſſion, and every part of it ſo loudly pleads for pity, that (as of ſcolds) it may (in another ſenſe) be ſaid of him, that he is all tongue. But yet this other beggar thinks not his condition the leſs deplorable for his companion's being the more ſo: he finds in the diſeaſes of his fellow as little conſolation as cure; nor does he at all think himſelf ſupplied with a deficient hand, becauſe the other wants one. And therefore he is as importunate for relief, as if all miſeries were not only heaped on him, but confined to him: his fellow's burthen lightens not his load; and if fortune never had perſecuted any other, he could not more deplore nor reſent her perſecutions. So that, if we ſhould judge of their miſeries rather by the ear than by the eye, this latter's ſadder complaints would move us to decree him the advantage in point of wretchedneſs.

TRANSLATE now, my ſoul, all this unto ſpirituals; and as we meaſure the ſtraightneſs of lines, not by a ram's horn, but a ruler; ſo be not thou ſo raſh, as to infer thy health from others more forlorn and deſperate diſeaſes. Let not the greater difficulty of another's cure leſſen the ſollicitouſneſs of thy care for thine, nor make thee leſs earneſt in the imploring and labouring for relief. In ſo depraved an age as ours, one may (and perhaps in vain too) ſearch hell to find wickeder men than are to be, but too frequently, met with upon earth: he will ſcarce be innocent, that will think himſelf ſo, as long as he finds a man more culpable than he; and he ſhall ſcarce ever judge himſelf guilty, whom the ſight of a guiltier will abſolve. Nor will that man (till it is perhaps too late) be apt to attempt an eſcape from the pollutions of the world, that ſtays till he can ſee none more inextricably intangled in them than himſelf. Do not therefore, O my ſoul, content thyſelf with that poor comparative innocence, that in heaven (which it will never bring thee to) has no place, by reaſon of the abſence of all vicious perſons; and in hell itſelf (which it ſecures not from) can afford only the ill-natured conſolation of not being altogether as miſerable, as the wretchedeſt perſon in that place of torment.

## REFLECTION VI.

### *Sitting at eaſe in a coach, that went very faſt.*

AS faſt as this coach goes, I ſit in it ſo much at eaſe, that whilſt its rapid motion makes others ſuſpect, that I am running for a wager, this lazy poſture, and this ſoft ſeat, do almoſt as much invite me to reſt, as if I were a-bed. The haſty wheels ſtrike fire out of the flints they happen to run over; and yet this ſelf-ſame ſwiftneſs of theſe wheels, which, were I under them, would make them cruſh my bones themſelves into ſplinters, if not into a jelly, now I am ſeated over them, and above their reach, ſerves but to carry me the faſter towards my journey's end. Juſt ſo it is with outward accidents, and conditions, whoſe reſtleſs viciſſitudes but too juſtly and too fitly reſemble them to wheels: when they meet with a ſpirit, that lies proſtrate on the ground, and falls groveling beneath them, they diſorder and oppreſs it; but he, whoſe high reaſon, and exalted piety, has, by a noble and ſteady contempt of them, placed him above them, may enjoy a happy and a ſettled quiet, in ſpite of all their buſy agitations; and be ſo far from reſenting any prejudicial diſcompoſure from theſe inferiour revolutions, that all thoſe changes, that are taken for the giddy turns of fortune's wheel, ſhall ſerve to approach him the faſter to the bleſt manſion he would arrive at.

## REFLECTION VII.

### *Upon the ſight of a windmill ſtanding ſtill.*

GENORIO, EUSEBIUS, LINDAMOR.

GEN. YOUR eyes, gentlemen, have been ſo long fixed upon this windmill, that, in ſpite of the barrenneſs of the ſubject, I cannot but ſuſpect, it may have afforded one, or each of you, an occaſional meditation.

EUSEB. To juſtify your conjecture, *Genorio*, I will confeſs to you, that I was conſidering with myſelf, that if one, who knew not the miller's trade and deſign, ſhould look upon this ſtructure, he would think the owner worthy of ſo incommodious a manſion, if not of a room in *Bedlam*; for, we ſee, he has choſe to erect this fabrick in a ſolitary place, and upon the cold and bleak top of a ſwelling ground, where nothing ſhelters it from the violence of a wind, whilſt its high ſituation expoſes it to the ſucceſſive violences of them all. But he that is acquainted with the exigencies of the miller's deſign and trade, will think he has made a proper choice, in ſeating himſelf in a place, where no wind can blow, that he ſhall not be able to make an advantage of. And having conſidered this, *Genorio*, my thoughts, when you interrupted them, were making this application of it; that we ought not to be too forward to cenſure men, otherwiſe virtuous, and diſcreet, for engaging themſelves, upon ſome accounts, to troubleſome and unſettling employments: for if the end be not miſchoſen, the means are to be eſtimated by their tendency thereunto; and though a calmer condition of life might be in itſelf more deſirable, yet when a more expoſed one can make him, that is qualified for ſuch employments, more ſerviceable in his generation, this may, upon that account, be more eligible than the other; ſince, as it expoſes him to more hardſhips, it affords him more opportunities of proſecuting his aims; ſo that his ſtation is recommended to him by thoſe very circumſtances, that make other men diſlike it.

GEN. But may not I alſo know what thoughts this worthy theme ſuggeſted to *Lindamor?*

LIND. I was, *Genorio*, taking notice, that this whole fabrick is indeed but a large engine, where almoſt every thing, as well as the ſails and the wheels, is framed and fitted for the grinding of corn: but though this whole ſtructure be artificially enough contrived, yet it can now do nothing in order to its end, for want of ſuch a light and airy thing as a breath of wind, to put all this into motion. And, *Genorio*, this windmill, thus conſidered, brought into my mind the condition of a great lord, that you and I not long ſince viſited, and who is far from being the only perſon, to whom the reflection may be applicable; for one, that not knowing his humour, and his aims, ſhould ſee how great a proviſion his plentiful fortune, and his ſkill to manage it, have laid together, of thoſe things, which are wont to be thought the chiefeſt inſtruments (and, perchance, the chief parts) of happineſs, would be apt to envy his condition, as diſcerning nothing that is wanting to it. But alas! the man expects and covets eſteem and reputation; and though fame have theſe reſemblances to the wind, that it is an airy and unſolid thing, which we muſt receive from others, and which we are not only unable to procure for our ſelves, but know not how long we ſhall keep it when we have it; yet the want of this alone makes all the reſt utterly inſufficient for his ſatisfaction. Thus the not ſo great as ambitious *Alexander*, after all the blood he had ſpilt in conquering the world, is ſaid to have ſhed tears, that he had conquered but one, when a philoſopher told him there were more. And all the favours, that the greateſt potentate upon earth could heap upon proud *Haman*, were, by his own confeſſion, unable to make him think himſelf happy, as long as he could not neglect a captive's neglect of him; all his greatneſs did him no good, if but one man had the courage not to bow to it; and an unſatisfied appetite of revenge quite ſpoiled the reliſh of the great monarch's favours, and the fair *Eſther*'s banquets. Nor do I doubt, *Genorio*, that we often marvel, if not repine, at providence, upon a great miſtake; for by refuſing to be God's ſervants, men uſually become ſo to their own unruly paſſions, and affections. And therefore we often very cauſeleſly envy the great and rich, as if they were as happy as the advantages vouchſafed them, would make a wiſe and good man; whereas perhaps the man courts a reputation, that is not to be acquired by what men have, but by what they are, and do; or elſe he is in love with a lady, that loves not him, or loves another better: and the coyneſs of a miſtreſs, the greater title of a neighbour, or ſome ſuch trifling accident, that another would either not be ſubject to, or not be much concerned for, will keep him from enjoying any of thoſe very things, for which by-ſtanders envy him: ſo juſt it is, that in eſtimating a man's condition, we ſhould not only conſider what poſſeſſions he has, but what deſires.

## REFLECTION VIII.

### *Upon his paring of a rare ſummer apple.*

HOW prettily has curious nature painted this gaudy fruit? Here is a green, that emeralds cannot, and *Flora*'s ſelf might boaſt: and *Pomona* ſeems to have affected, in the freſh and lively vermilion that adorns this ſmooth rind, an emulation at rubies themſelves, and to have aimed at manifeſting, that ſhe can give her vegetable productions as lovely and orient, though not as laſting colours, as thoſe that make jewels precious ſtones; and if, upon the hearing the praiſes this ſcarlet deſerves, her bluſhes ennoble her own cheeks with ſo vivid a colour, perhaps ſuch a livery of her modeſty might juſtify her pride. In a word, ſuch pure and tempting green and red dye this ſame poliſhed ſkin, that our vulgar boldneſs muſt be no longer queſtioned, for rendering that fruit an apple, that inveigled our firſt parents. But though theſe winning dyes delight me ſtrangely, they are food for my eye alone, and not my ſtomach; I have no palate for colours; and to reliſh this fruit well, and know whether it performs to the taſte what it promiſes to the ſight, and juſtify that Platonick definition, which ſtyles beauty the luſtre and flower of goodneſs, all this gay outſide is cut and thrown away, and paſſes but for parings. Thus, in opinions, though I look with pleaſure on that neat faſhionable dreſs, that ſmoother pens ſo finely cloathe them with; and though I be delighted with the pretty and ſpruce expreſſions, that wit and eloquence are wont to trick them up with; yet when I mean to examine their true reliſh, that, upon liking, I may make them mine, I ſtill ſtrip and diveſt them of all thoſe flattering ornaments (or cheating diſguiſes rather) which ſo often conceal or miſrepreſent their true and genuine nature, and (before ever I ſwallow them) after they have been admitted by the more deluſible faculty we call fancy, I make them paſs the ſeverer ſcrutiny of reaſon.

## REFLECTION IX.

*Upon his coach's being ſtopt in a narrow lane.*

HERE, for aught I can gueſs, my ſtay is like to be long enough, to afford me the leiſure of a reflection on it: for I have found already, in this narrow lane, a very large ſcene to exerciſe my patience in; and this churliſh drayman ſeems reſolved to be as tedious to me, as *Ludgate-Hill* is to his horſe, when his cart is overloaden. They, that are going on foot to the ſame place this coach ſhould carry me to, find not their paſſage hindered, or their way obſtructed by that, which keeps me here; and were I diſpoſed to leave my coach behind, and foot it after them, I might in their company ſooner reach the place my deſigns and affairs call me to, than I ſhall (probably) be ſupplied with hopes of getting quickly out from hence. Alas! how frequently falls it out thus in our journeys towards heaven? Thoſe, whom their adverſe fortune, or a noble ſcorn, hath ſtript of, or releaſed from, theſe troubleſome and intangling externals, may tread the paths of life nimbly and chearfully, being unſtopt by many obſtacles, that intercept the progreſſes of others. But thoſe ſtately perſons, whoſe pride or effeminacy will not permit them to move an inch towards heaven, unleſs they may be carried thither in pleaſure's eaſy coaches, and who will not bate a ſuperfluity, or lay by the leaſt circumſtance or punctilio of grandezza, to leſſen themſelves into a capacity of entering in at the ſtrait gate, may ſoon find theſe treacherous and over-loved conveniencies turned into cumberſome clogs, and real impediments, that will, if not block up, at leaſt obſtruct the paſſage to the ſeat of ſo much joy; that even to be caſt aſhore there, by ſhipwreck, were a bleſſing; and that he is thought unworthy to be admitted there, that cannot think it his happineſs to reach that place himſelf, though he leave all behind him to get thither.

## REFLECTION X.

*Looking through a perſpective glaſs upon a veſſel we ſuſpected to give us chace, and to be a pirate.* [*Sailing betwixt* Rotterdam *and* Graveſend *on* Eaſter-day, 1648.]

THIS glaſs does indeed approach the diſtruſted veſſel, but it approaches her only to our eyes, not to our ſhip; if ſhe be not making up to us, this harmleſs inſtrument will prove no loadſtone to draw her towards us; and if ſhe be, it will put us into a better readineſs to receive her. Such another inſtrument in relation to death is the meditation of it; (by mortals ſo much, and ſo cauſeleſly, abhorred:) for though moſt men as ſtudiouſly ſhun all thoughts of death, as if, like nice acquaintances, he would forbear to viſit, where he knows he is never thought of, or as if we could exempt ourſelves from being mortal, by forgetting that we are ſo; yet does this meditation bring death nearer to us, without at all leſſening the real diſtance betwixt us and him: if that laſt enemy be not yet approaching us, this innocent glaſs will no more quicken his pace, than direct his ſteps; and if he be, without haſtening his arrival, it will prepare us for his reception. For my part, my beardleſs chin allows me to preſume, that by the courſe of nature, I have yet a pretty ſtock of ſand in the upper part of my hour-glaſs: wherefore, though I am now too young to ſay with *Iſaac*, *Behold, now I am old, and I know not the day of my death*, Gen. xxvii. 2. yet ſince the youngeſt and luſtieſt of us all has cauſe to ſay with the mirror of patience, *When a few years are come, then ſhall I go the way whence I ſhall not return*, Job xvi. 22. and ſince it is the wiſe man's counſel, *Not to boaſt ourſelves of to-morrow, becauſe we know not what a day may bring forth:* I will endeavour (to uſe our Saviour's terms) *to take heed to myſelf, leſt at any time that day come upon me unawares*, Luke xxi. 34. And, as the only ſafe expedient in order thereunto, I will (in imitation of holy *Job*) *All the days of my appointed time, wait till my change come*, Job xiv. 24.

## SECT. II.

## *Containing* OCCASIONAL REFLECTIONS *upon the Accidents of an Ague.*

### MEDITATION I.

*Upon the firſt invaſion of the diſeaſe.*

THIS viſit, dear * *Sophronia*, which you intended but for an act of kindneſs, proves alſo one of charity; for though it be not many hours ſince we parted, and though you left me free from any other diſcompoſure than that, which your leaving me is wont to give me; yet this little time has made ſo great a change in my condition, as to be, I doubt not, already viſible in my looks: for whilſt I was ſitting quietly in my chamber, and was as far from the thoughts of ſickneſs, as from any ſuch diſorders, as are wont to be the occaſions of it; and whilſt I was delightfully entertained by an outlandiſh virtuoſo, that came to viſit me, with an account of the ſeveral attempts, that are either made, or deſigned in foreign parts, to produce curioſities, and improve knowledge; I was ſuddenly ſurprized with a chilneſs, and a ſhivering, that came ſo unexpected, and increaſed ſo faſt, that it was heightened into a downright fit of an ague, before I could ſatisfy myſelf what it was. But I confeſs, that this unwelcome accident had not amazed me, as well as troubled me, if I had ſufficiently conſidered, to what a ſtrange number and variety of diſtempers theſe frail carcaſes of ours are obnoxious; for, if I had called to mind, what my curioſity for diſſections has ſhown me, and remembred how many bones, and muſcles, and veins, and arteries, and griſtles, and ligaments, and nerves, and membranes, and juices, a human body is made up of, I could not have been ſurprized, that ſo curious an engine, that conſiſts of ſo many pieces, whoſe harmony is requiſite to health, and whereof not any is ſuperfluous, nor ſcarce any inſenſible, ſhould have ſome or other of them out of order, it being no more ſtrange, that a man's body ſhould be ſubject to pain, or ſickneſs, than that an inſtrument with above a thouſand ſtrings (if there were any ſuch) ſhould frequently be out of tune; eſpecially ſince the bare change of air may as well diſcompoſe the body of a man, as untune ſome of the ſtrings of ſuch an inſtrument; ſo that even the inimitable ſtructure of human bodies is ſcarce more admirable, than that ſuch curious and elaborate engines can be ſo contrived, as not to be oftner out of order than they are; the preſervation of ſo nice and exact a frame being the next wonder to its workmanſhip. And indeed, when I conſider further, how many outward accidents are able to deſtroy the life, or at the leaſt, the health, even of thoſe, that are careful to preſerve them; and how eaſily the beams of a warm ſun, or the breath of a cold wind, or too much, or too little exerciſe, a diſh of green fruit, or an infectious vapour, or even a ſudden fright, or ill news, are able to produce ſickneſs, and perhaps death; and when I think too how many evitable miſchiefs our own appetites, or vices, expoſe us to, by acts of intemperance, that neceſſitate the creatures to offend us, and practices of ſin, whereby we provoke the Creator to puniſh us: when, I ſay, I conſider all this, and conſequently how many miſchiefs he muſt eſcape that arrives at grey-hairs; I confeſs, the commonneſs of the ſight cannot keep me from thinking it worth ſome wonder, to ſee an old man, eſpecially if he be any thing healthy. But theſe kind of thoughts, *Sophronia*, are ſeldom entertained, unleſs they be excited by ſome unwelcome occaſions; and when we are long accuſtomed to health, we take it for granted, that we ſhall enjoy it, without taking it for a mercy that we are ſo: we are not ſenſible enough of our continual need and dependance on the divine goodneſs, if we long and uninterruptedly enjoy it; and by that unthankful heedleſſneſs we do, as it were, neceſſitate providence to deprive us of its wonted ſupports, to make us ſenſible, that we did enjoy, and that we always need them: it being but fit, that mercies ſhould ceaſe to be conſtant, which their conſtancy only, that ſhould be their indearment, keeps us from entertaining as mercies. I will therefore, *Sophronia*, endeavour to derive this advantage from this ſudden fit of ſickneſs, to make me thankful for health, when God ſhall be pleaſed to reſtore it me, and to keep me from reckoning confidently upon the laſtingneſs of it. For though we are very unapt to take even the wiſe man's counſel, where he forbids us to *boaſt ourſelves of to-morrow, becauſe we know not what a day may bring forth*; yet by ſuch accidents I find, that *Solomon* ſpoke much within compaſs, and had not done otherwiſe, if for a day he had ſubſtituted an hour: for ſo many, and ſo various are the unforeſeen accidents, to which we poor mortals are expoſed, that the continuance of our health or proſperity do much more merit our thanks, than the interruption of them can deſerve our wonder. And I muſt confeſs, *Sophronia*, that though my falling ſick may be but my unhappineſs, my being ſo much ſurprized as it was my fault.

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* A name often given by the Author to his excellent Siſter *R.* who was almoſt always with him, during his ſickneſs.

## MEDITATION II.

*Upon the immoderate heat and cold of the aguiſh fit.*

ONE that, not knowing what ails me, ſhould come in, and ſee me in this ſoft bed, not only covered, but almoſt oppreſſed with clothes, would confidently conclude, that, whether or no I be diſtreſſed by the contrary quality, I cannot at leaſt be troubled with cold; and if he himſelf were ſo, he will be apt to envy me. And if, inſtead of coming in my cold fit, he ſhould viſit me in my hot one, and ſee me with my ſhoulders and arms quite uncovered, and nothing but the ſingle ſheet on the reſt of my body; he would be apt to think, that I muſt lie very cool. But alas! in ſpite of all that lies upon me, an internal froſt has ſo diffuſed it ſelf through every part, that my teeth chatter, and my whole body does ſhake ſtrongly enough to make the bed it ſelf do ſo; and, though I ſtill wiſh for more clothes, yet thoſe, that are heaped on me, can ſo little controul this preternatural cold, that a pile of them might ſooner be made great enough to cruſh, than to warm me; ſo that when I travelled even in froſty nights, the winter had nothing near ſo ſtrong an operation on me. And as that external cold was far more ſupportable whilſt it laſted, ſo it was incomparably more eaſy for me, by exerciſe, and otherwiſe, to deliver my ſelf from it.

THUS, when a great or rich man's mind is diſtempered with ambition, avarice, or any immoderate affection, though the by-ſtanders, that ſee not what diſquiets him, but ſee what great ſtore of accommodations fortune has provided for him, may be drawn to envy his condition, and be kept very far from ſuſpecting, that he can want that contentment, the means of which they ſee him ſo richly ſupplied with: and yet alas! as the colder heat of the external air is much leſs troubleſome to a man in health, though furniſhed with an ordinary proportion of clothes, than the cold or hot fit of an ague, with a pile of blankets firſt, and then a ſingle ſheet; ſo to a vigorous and healthy conſtitution of mind, external inconveniences are much more ſupportable, than any accommodations can make the condition of a diſtempered ſoul. Let us not then judge of men's happineſs, ſo much by what they have, as by what they are; and conſider both, that fortune can but give *much*, and it muſt be the mind, that makes that much *enough*: and that, as it is more eaſy to endure winter, or the dog-days in the air, than in the blood; ſo a healthful mind, in ſpite of outward inconveniences, may afford a man a condition preferable to all external accommodations without that.

## MEDITATION III.

*Upon the ſucceſſion of the cold and hot fit.*

WHEN the cold fit firſt ſeized me, methought it was rather melted ſnow than blood, that circulated in my veins, where it moved ſo inordinately, and maintained the vital flame ſo penuriouſly, that the greateſt ſign, which was left to diſtinguiſh this cold from that of death, was its making me ſhake ſtrong enough to ſhake the bed I lay on. I called for more and more clothes, only becauſe I needed them, not becauſe I found any relief by them: I fancied the torrid zone to be of a far more deſirable conſtitution than that we call the temperate; and as little as I am wont to reverence vulgar chymiſts, I then envied their laborants, whoſe imployment requires them to attend the fire. But when the cold fit was once over, it was quickly ſucceeded by a hot one, which after a while I thought more troubleſome than it.

I threw off the clothes much faſter than my former importunity had procured them to be laid on me; and I, that could a little before ſcarce feel all that had been heaped on me, could not now ſupport a ſingle ſheet, but thought its weight oppreſſed me.

I ENVIED the inhabitants of *Norway*, and *Iceland*, far more than thoſe, that dwell either in the richeſt province of *Eaſt India*, or of the Golden Coaſt it ſelf: and of all creatures, not rational, I thought the fiſhes the happieſt, ſince they live in a cool ſtream, and, when they pleaſe, may drink as much as they liſt.

IF then, *Sophronia*, the ſelf-ſame perſon may, within leſs than two hours, have ſuch different apprehenſions of his own condition, as now to complain of that as a ſad grievance, which but an hour before he wiſhed for as a relief; we may well acknowledge, that we frequently miſtake in eſtimating the hardſhips and afflictions we complain of, and find them not ſo uneaſy as we make them, whilſt we not only endure the whole affliction, that troubles us, but often increaſe it, by repining at the envied condition of others.

AN afflicted man is very apt to fancy, that any kind of ſickneſs, that for the preſent troubles him, is far leſs ſupportable, than if it were exchanged for another diſeaſe; and imagines his caſe to be ſo ſingular, that one cannot ſay to him in St. *Paul*'s language, *No temptation has befallen you, but that which is common to men*, 1 Cor. x. 13. He preſumes, that he could far more eaſily ſupport his croſſes, if inſtead of his preſent diſeaſe, he had this or that other; though, if the exchange were made, he would, perchance, wiſh for his firſt ſickneſs, if not be as much troubled at his own folly, as with the diſeaſe. He that is tormented with the gout, is apt to envy any ſick man, that is exempted from that roaring pain, and able to walk about: he that is ſwelled with the dropſy, fancies all perſons happy, whoſe diſeaſes allow them drink to quench their thirſt: and the blind man envies both theſe, and thinks no perſons ſo miſerable in this world, as thoſe that cannot ſee the world. Fevers burn us, agues ſhatter us, dropſies drown us, phrenſies unman us, the gout tortures us, convulſions wrack us, epilepſies fell us, colicks tear us; and in ſhort, there is no conſiderable diſeaſe that is not very troubleſome in it ſelf, however religion may ſanctify and ſweeten it: for as a fortreſs, whoſe defendants are not treacherous, can ſcarce be taken otherwiſe than either by famine, or ſtorm; ſo life, for whoſe preſervation nature is ſo faithfully ſollicitous, cannot be extinguiſhed, unleſs either chronical diſeaſes do lingeringly deſtroy, or ſome acute do haſtily ſnatch it away. And indeed, if a diſeaſe prove mortal, it is no more than is to be expected, if it tire out the patient with tedious languiſhments, or elſe diſpatch him with diſmal ſymptoms: nor is it in point of ſickneſs only, that we are often more unhappy than we need, by fancying ourſelves more unhappy than we ſhould be, if we were allowed to exchange that, which now troubles us, for any thing which does not. But there are evils, which, though exceeding contrary in appearance and circumſtances, do yet agree in being extremely troubleſome; as the poſſeſt wretch our Saviour cured in the Goſpel, though he were ſometimes caſt into the fire, and ſometimes into the water, yet in both ſtates was tormented by the ſame devil, who, in variety of inflictions, ſtill expreſſed the ſame malice. But we ſhould make a righter eſtimate of ſuffering, if we did but conſider, that much uneaſineſs is annexed to an afflicted condition in general; and that therefore, which we are ſenſible of, may proceed rather from the general nature of ſickneſſes, and croſſes, than from the particular kind and degree of ours. And indeed, if a man were permitted to exchange his diſeaſe with thoſe of others, he would often find his granted wiſhes to bring him a variety of miſchiefs, rather than an exemption from them; and many of thoſe, that we envy, as thinking them far leſs ſufferers than our ſelves, do look with invidious eyes on us, and do but diſſemble their grievances more handſomely than we, not find them more eaſy than ours. And that of St. *Peter* may be more generally applied, than moſt men think, where he exhorts to conſtancy, upon this conſideration, *That the ſame ſufferings are accompliſhed upon our brethren in the world*, 1 Pet. v. 9. For it is all one as to the efficacy of this lenity, whether our afflictions be the ſame with thoſe of others, in kind, or not ſuperiour to them in degree: and I doubt not, but we ſhould ſupport many of our grievances as eaſily as thoſe, for which we wiſh them exchanged, if the chief account, upon which they trouble us, were not rather, that they are the preſent ones, than the greateſt.

## MEDITATION IV.

### *Upon the being let blood.*

ONE of the moſt troubleſome ſymptoms in almoſt all feveriſh diſtempers is wont to be thirſt; and in mine it was importunate to a degree, that made me very much ſo, in frequently ſolliciting thoſe, that were about me for drink, which, in the heat of the fit, ſeemed ſo deſirable an object, that it then much leſſened my wonder at that parched king's agreement, who, urged with thirſt, ſold his liberty for a full draught of cold water. But alas! I ſadly found, that the liquor I ſwallowed ſo greedily, afforded me but a very tranſient relief, the latter being gone almoſt as ſoon as the former had paſſed thorough my throat; ſo that not only it did but amuſe me, not cure me; but, which is worſe, drinking it ſelf increaſed my thirſt, by increaſing the fever, whoſe uneaſy ſymptom that was. Wherefore, ſeeing all the cooling juleps that could be adminiſtered, did free me from nothing but the expectation of being much relieved by ſuch ſlight and palliative medicines; the doctor thought himſelf this day obliged to a quite contrary, and yet a more generous remedy; and ordered, that, inſtead of giving me drink, they ſhould take away blood, as judging it the beſt and far the ſureſt courſe to take away the uneaſy ſymptoms, by removing that, which foments the cauſe.

THUS when the mind is diſtempered with turbulent commotions, and the diſquieted appetites do too reſtleſsly and eagerly crave objects, which, though perhaps in themſelves not abſolutely bad, are at leaſt made, by a conjunction of circumſtances, unfit and dangerous for the perſon that longs for them: we, like unſkilful or unruly patients, fondly imagine, that the only way to appeaſe our deſires is, to grant them the objects they ſo paſſionately tend to. But the wiſe and ſovereign phyſician of ſouls, who conſiders not ſo much what we do wiſh, as what we ſhould wiſh, often diſcerns, that this præternatural thirſt indicates and calls for a lancet, rather than a julep, and knows it beſt to attempt the cure, rather by taking away ſomewhat that we have, than by giving us that, which only a ſpiritual ſuperfluity reduces us to want. And in effect, we often ſee, that as a few ounces of blood taken away in a fever do cool the patient more than the giving him ten times as much drink would do; ſo a few afflictions, by partly letting out, and partly moderating our corrupt affections, do more compoſe and appeaſe a mind moleſted with inordinate appetites, than the poſſeſſion of a great many of the objects we impotently deſire. Whilſt our appetites are roving, and unreaſonable, and inſatiate, the obtaining of this or that particular object does but amuſe the patient, not take away the diſeaſe; whereas ſeaſonable and ſanctified croſſes, that teach us to know our ſelves, and make us ſenſible how little we deſerve, and how little the things we are ſo greedy of could make us happy, if obtained, may reduce us to a reſignation, and tranquillity of mind, preferable to thoſe over-valued things, which, as it keeps us from enjoying, ſo it keeps us from needing. Thus *Zacheus*, who, whilſt a publican, never thought he had enough, when he had once entertained our Saviour, though he offered to make a quadruple reſtitution of whatever he had fraudulently acquired, was, upon a ſudden, by being freed from avarice, grown ſo rich, that he was forward to give no leſs than half he had to the poor; as if his divine gueſt had wrought upon his goods ſuch miracles, as he had done upon the five loaves, and two fiſhes, of which the remains amounted to more than the whole proviſion was at firſt.

## MEDITATION V.

### *Upon the taking of phyſick.*

THE laſt bitter potion that I took, *Sophronia*, was, I remember, ſweetned with the hopes that were given me with it, that it might prove the laſt I ſhould need to take, and would procure me a ſettled and durable health: but I find by ſad experience, that the benefit I derived from it is nothing near ſo laſting as it was welcome; for I am now reduced to take phyſick again, and I fear muſt often do ſo, before I ſhall be able to diſlodge this troubleſome ague that haunts me. For though the laſt phyſick I took, wrought ſo well, that I hoped it had brought away not only the ill-humours themſelves, but the very ſources of them; yet by the effect of what I took this morning, I not only find there is as much to be purged away now, as there was then, but, what is ſadder, I can ſcarce hope this phyſick will excuſe me from the need of taking more again ere long. But though it is a troubleſome thing, and muſt be often repeated, yet it is a ſalutary thing too, and cannot be more unpleaſant than it is uſeful; and as loathſome as it is, a ſickneſs were far worſe. Thus when a relenting ſinner has endeavoured to waſh away his ſins with his tears, he may poſſibly think himſelf ſo thoroughly waſhed in that abſterſive brine, (which yet owes its cleanſing virtue not to its own nature, but to the blood of Chriſt) that if he be a new convert, and be entertained with thoſe raviſhing delights, wherewith God is often pleaſed to engage ſuch returning prodigals, (as the kind father welcomed his riotous ſon with feaſting, and with muſick) that he is apt to fancy repentance to be like baptiſm, which, being received once for a man's whole life, needs never be renewed. But though, during ſuch tranſports, an unexperienced convert may be apt to caſt the gauntlet to the world, ſaying in his ſpiritual proſperity, that he ſhould never be moved; yet, as our Saviour ſpeaks, *The ſpirit indeed is willing, but the fleſh is weak:* and too commonly our reſolutions flag with our joys, and thoſe that a while before imagined they deſpiſed the world, find themſelves worſted, if not captivated, by it; and find it far more difficult than they thought it, to live in the company of ſinners without being of their number, and in ſo defiled a world without being ſpotted by it.

AND as the ſame *David*, who ſaid in his proſperity, he ſhould never be moved, ſaid in his diſtreſs, he ſhould one day periſh by the hand of *Saul*; ſo many of thoſe, that whilſt their tears of repentance, and of joy, are not yet dried off their eyes, are apt to defy and contemn all the ghoſtly enemies, and difficulties, that oppoſe their preſent zealous reſolutions, will, perhaps, in a while after, when they meet with unexpected impediments, and foils, change their confidence into deſpair, and think thoſe very enemies, whom they lately looked on as deſpicable, to be inſuperable. But as phyſick, that does good for a time, ought not to be rejected, becauſe it does good but for a time; nor ſhould we reject the only ſure means of our preſent recovery, for fear of future relapſes: ſo, though we ſadly find, that repentance muſt be repeated, and that after we have practiſed it often, we muſt have need of it again; yet ſince it is the only proper means to recover a ſoul out of a ſtate of ſin, which is worſe than any diſeaſe, and leads to the worſt of deaths, we muſt never ſuffer our ſelves to be ſo far diſcouraged, as to forego ſo neceſſary and ſo profitable a duty, and muſt not more frequently relapſe into faults, than renew our ſorrow for them, and our reſolves againſt them: for innocence indeed is far more deſirable than repentance, as health is than phyſick. But as phyſick is more eligible than the continuance of ſickneſs, ſo is repentance more eligible than continuing in the ſtate of ſin: and as the drinking even of a bitter potion is a leſs evil than the heat, and thirſt, and reſtleſſneſs of an ague; ſo to lament for ſin here, is a far leſs uneaſy thing, than to do it in a place, where there is nothing but remedileſs wailing, and gnaſhing of teeth. It is true, that our ſouls are in this too like our bodies, that our whole lives are ſpent betwixt purging away of naughty humours, and accumulating them: and methinks, I hear the fleſh ſtill ſaying unto the ſpirit, as *Ruth* did to *Naomi*, *the Lord do ſo to me*, *and more alſo*, *if aught but death part thee and me*, Ruth i. 14. But although there are defilements, which, though often waſhed off, will as often come again to blemiſh us; and though the *deeds of the* * *body* will ſcarce all of them perfectly be put to death, but with the body it ſelf; yet next to an uninterrupted ſtate of health, frequent and early recoveries are deſirable: and though the ſhameful neceſſity of needing to beg many pardons for the ſame fault may juſtly make an ingenuous Chriſtian cry out with Saint *Paul*, *O wretched man that I am! who ſhall deliver me from the body of this death?* yet the ſame ſenſe of his own frailty, that puts this exclamation into his mouth, may comfort his heart, by its being a pledge, that he ſhall one day be able exultingly to ſay with the ſame Apoſtle in another place, *Thanks be to God*, *which giveth us the victory*, *through our Lord Jeſus Chriſt*, 1 Cor. xv. 57.

Rom. viii. 13.
* Θανατόω.

## MEDITATION VI.

*Upon the ſyrups and other ſweet things ſent him by the Doctor.*

THIS complaiſant phyſician, *Sophronia*, is, you ſee, very ſollicitous, that his remedies ſhould as well gratify the patient, as oppoſe the diſeaſe: and beſides that this julep is tinged with ſyrup of clove-july-flowers, that it may at once delight the palate, and the eye; ſome of theſe other remedies are ſweetned with as much ſugar, as if they came not from an apothecary's ſhop, but a confectioner's. But my mouth is too much out of taſte to reliſh any thing, that paſſes through it; and though my ſickneſs makes this flattering of the palate almoſt neceſſary to the rendring theſe medicines takable by me, yet upon the account of the ſame diſtemper, all that the Doctor's tenderneſs and ſkill could do to make them *pleaſant*, can at moſt but keep them from being *loathſome*. And therefore you will eaſily believe, *Sophronia*, that I enjoy theſe ſweet things upon a ſcore, that, if it does imbitter them, does at leaſt, as to me, deprive them of their nature: ſo that he, that, for the ſake of theſe ſyrups and electuaries, ſhould, notwithſtanding the malady that needs them, envy me, might be ſuſpected to be troubled with a worſe diſeaſe than an ague is, a frenzy.

THUS there are many favourites of fortune, whoſe ſeeming enjoyments may, perchance, be envied by thoſe, that do but gaze on their condition, whilſt it is rather pitied by thoſe that know it. To be brought by greatneſs of power, or riches and effeminacy of mind, to that paſs, that they ſeldom hear any thing but their own praiſes, even when their actions merit reprehenſion, and that they can reliſh nothing that is not ſweetned with ſo much of flattery, as quite to diſguiſe, and perhaps pervert, its nature: theſe, as I was going to ſay, and ſuch other unhappy privileges, are things, which (whatever fools may think) will not recommend greatneſs to a conſidering man, and are far more fit to procure the poſſeſſor's ruin, than wiſe men's envy: and beſides that a vain and impotent ſoul is, by thoſe diſquieting qualities, moleſted with greater diſtempers, than thoſe gratifications can make amends for, and which often hinder the full reliſhing of theſe or any other pleaſures. The delight theſe treacherous delicacies afford, is ſo much leſs conſiderable than the weakneſs they ſuppoſe; that it is far more eligible to be without them than to need them.

## MEDITATION VII.

### *Upon the want of ſleep.*

AH! dear *Sophronia*, in ſpite of all the care and officiouſneſs of thoſe diligent attendants, that you were pleaſed to ſend to watch with me, I have ſlept all night as little as I do now, or as I ſhall deſire to do whilſt you ſtay here.

THIS unwelcome leiſure brought me as much a neceſſity, as an opportunity to ſpend the time in entertaining my thoughts, which on this occaſion were almoſt as various, and ſeemed too as wild, as, if I had ſlept, my dreams themſelves would have been: and therefore, I preſume you will not wonder, if I can now recall but few of them, and if the reſt be as eaſily vaniſhed out of my memory, as they came abruptly into my mind.

THE firſt thought, that I remember entertained me, was that, which was the moſt naturally ſuggeſted by the condition I was in: for when I found how tedious and wearisome each hour was, and obſerved how long a time ſeemed to intervene betwixt the ſeveral diviſions, that the ſtriking of the clock made of a night, that muſt at this time of the year be much ſhorter than the day; I could not but conſider, how inſupportable their condition muſt be, to be caſt into outer darkneſs, where tormented wretches lie, not as I do upon a ſoft bed, but upon fire and brimſtone, where no attendance of ſervants, or kindneſs of friends, is allowed them, that need it as much as they deſerve it little; and, which is worſt of all, where no beam of hope is permitted to conſolate them, as if the day ſhould dawn after ſo diſmal a night, though protracted to millions of ages, each of whoſe miſerable hours appears an age.

THE next thing I was conſidering, was, how defective we are in point of gratitude to God: I now bluſh, that I cannot call to mind the time, when I ever thought, that his having vouchſafed me the power of ſleeping deſerved a particular acknowledgment. But now I begin to ſee, that it is our heedleſſneſs, not their uſeleſſneſs, that keeps us from daily being thankful for a multitude of mercies, that we take notice of; though it be injurious, that that only commonneſs, that heightens the benefit, ſhould keep us from being ſenſible of the greatneſs of it. I confeſs I was very lately one of them, who looked upon ſleep as one of thoſe inconveniences of human nature, that merit a conſolation; and I very little apprehended, that I ſhould ever complain of the want of ſleep, as of a grievance, the neceſſity of it being what I always looked upon under that notion. But I now perceive, he was a wiſe man, who ſaid, *That God made every thing beautiful in its ſeaſon.* And yet, when I conſider the affinity betwixt ſleep and death, whoſe image it is, I cannot but think it very unlikely, that this life ſhould be deſigned for our happineſs, ſince not to loſe almoſt half of it were an infelicity.

ANOTHER thing I remember I was conſidering, was this, that though want of ſleep be one of the uneaſieſt accidents, that attend on ſickneſs, yet in many caſes it proves as uſeful as it can be unwelcome. For there is a ſort of jolly people, far more numerous than I could wiſh them, who are at utter defiance with thinking, and do as much fear to be alone, as they ſhould to do any courſe, that is naturally productive of ſo unmanly a fear: and the ſame ſinful employments, or vain paſtimes, that make them afraid of being alone, do ſo much keep them from the neceſſity of being ſo, that they keep them almoſt from the very poſſibility of it. For in the time of health, viſits, buſineſſes, cards, and I know not how many other avocations, which they juſtly ſtyle diverſions, do ſucceed one another ſo thick, that in the day there is no time left for the diſtracted perſon to converſe with his own thoughts: and even, when they are ſick, though they be debarred of many of thoſe wonted diverſions, yet cards and company will give them enough to prove a charm againſt thinking, which the patient is ſo willing, or rather ſollicitous, to decline, the need of that ſickneſs leſs troubles him, as it keeps his body from going abroad, than as it tends to drive his thoughts home; ſo that ſickneſs does little or nothing towards the making ſuch men conſider, by caſting them upon their beds, unleſs it alſo hinder them from ſleeping there. But in the long and tedious nights, when all the praters, and the gameſters (who are uſually called good companions, but ſeldom prove good friends) are withdrawn, and have left our patient quite alone, the darkneſs of the night begins to make him diſcern, and take ſome notice of his own condition, and his eyes, for want of outward objects, are turned inwards, he muſt, whether he will or no, during the ſilence of the night, hear thoſe leſſons, which by the hurry and avocations of the day he endeavoured to avoid. And though this be a very unwelcome mercy, yet it is a mercy ſtill, and perhaps the greater for being ſo unwelcome: for if he could ſleep in ſickneſs, as he uſed to do in health, he were in great danger of having his conſcience laid aſleep, till it ſhould be awaked by the flames and ſhrieks of hell. And the deſign of God in chaſtening being to reclaim and amend us, we not only do, by our want of reflecting, endure the trouble of ſickneſs, without reaping the benefit of it; but alſo by our ſhunning to conſider, we are ſo ill-natured to our ſelves, as to lengthen the ſickneſs, we are ſo impatient of; which is in us as fooliſh, as it would be in a nice patient, after having been made to take a bitter, but a ſalutary potion, to ſend unſeaſonably for cordials and juleps to hinder the working of it, and ſo by ſuch unrulineſs loſe the benefit of the operation, and lengthen his pain and ſickneſs, to avoid the far leſs trouble of complying with the nature of the medicine, and the deſigns of the phyſician: ſo that repentance being neceſſary to recovery, and the conſidering of a man's own ways as neceſſary to repentance, the want of ſleep, which both allows us time, and impoſes on us a neceſſity to think, may well be looked upon as a happy grievance, ſince it very much tends to the ſhortning of our afflictions, by the diſpoſing us to co-operate towards God's aims in ſending them.

## MEDITATION VIII.

### *Upon telling the ſtrokes of an ill-going clock in the night.*

THE ſame violence of my fit, that made me very much need ſleep, allowed me ſo little of it, that I think I miſſed not hearing one ſtroke of the clock all the night long. But ſince you know, *Sophronia*, that the clock is kept by the ſoldiers, that are quartered in the place where it ſtands, you will eaſily believe, that it is not very carefully looked to; eſpecially ſince they are not only wont to let it go ill, but do oft times make it do ſo on purpoſe, and as may beſt comply with the officers occaſions, and as they would have the guards, that are to be ſet here, or to be ſent hence, ſooner or later relieved. Of this uncertain going of the clock I never had occaſion to take ſo much notice as the laſt night, when, lying too conſtantly awaked, I began to obſerve, that though all the hours were ſo tedious, as to ſeem every one of them extraordinarily long, yet they manifeſtly appeared to me not to be equally ſo; and therefore, when the clock ſtruck eleven, to ſatisfy my ſelf, whether it did not miſ-inform me, I called to one that ſat up by me for the watch I uſe to meaſure the time with in nice experiments, and found it to want but very little of midnight; and not much above an hour after, when by my watch it was but about one, thoſe that kept the clock, whether out of negligence, or deſign, or to make amends for paſt ſlowneſs, made it ſtrike two; which ſeemed to me to hint a not unuſeful rule in eſtimating the length or ſhortneſs of diſcourſes: for there are caſes, where the difficulty or importance of the ſubject is ſuch, that though it coſt a man many words, yet if what he ſays be not ſufficiently fitted to the exigency of the occaſion, and the theme, he may ſpeak much, without ſaying enough. But on the other hand, if (as it often happens) a man ſpeak either unſeaſonably, erroneouſly, or impertinently, he may, though he ſay little, talk too much; the paucity or number of words is not, as many think it, that, which is in ſuch caſes to be chiefly conſidered; for it is not many, or few, that are required, but enough. And, as our clock ſtruck not ſo often as it ſhould have done, when it ſtruck eleven, and yet ſtruck a while after too often when it ſtruck but two, becauſe the firſt time it was midnight, and the ſecond time it was but one of the clock; ſo to eſtimate, whether what is ſaid have its due length, we are not ſo much to look, whether it be little, or much, as whether a man ſpeak in the right time, and ſay neither more nor leſs than he ſhould.

## MEDITATION IX.

### *Upon comparing the clock and his watch.*

THE occaſion I had, *Sophronia*, to compare the clock and my watch, ſuggeſted to me this other reflection, that the dial-plate of the clock being I know not how many times larger than that of the watch, the circle, on which the hours were marked in the one, did by vaſt odds exceed the correſpondent circle of the other: and yet, though the index of the clock had then paſt through a far greater quantity of ſpace than that of the watch, this little index, being, when it was indeed midnight, arrived at the mark of the twelfth hour, when the greater index was come but to that of the eleventh, I juſtly concluded, that the watch did not only go truer, but more forward than the clock.

THUS in eſtimating men's lives, there is ſomething elſe to be looked at than the mere duration of them; for there are ſome men, who having loitered and trifled away very many years in the world, have no other argument of their age, than the church-books or their grey-hairs; and as little do they indeed live, that waſte a number of inſignificant years in ſucceſſive or perpetual diverſions from the true buſineſs and end of life. Theſe, and many other kind of perſons, that conſume much time to little purpoſe, may be ſaid rather to have laſted long, than to have lived long: as the careleſs wanderer, who, inſtead of travelling, does nothing but ſtray from one wrong way to another, though he do ſo at midſummer, from morning to night, may be ſaid to have been long on horſe-back, but not to have performed a long journey: whereas he, that by thrifty huſbanding his time, and induſtriouſly improving it, has early diſpatched the buſineſs, for which he was ſent into the world, needs not grey hairs, to be reputed to have lived long enough, and conſequently longer than thoſe, that wear grey-hairs, only becauſe they were born many years before him. In a word, to one of thoſe ſort of men we may attribute a longer time, but to the other a longer life; (for even the Heathen could ſay, *Non eſt vivere, ſed valere vita)* and within how narrow a compaſs ſoever a man's life be confined, if he have lived ſo long, as, before he comes to the end of life, he have reached the ends of living; the attainment of that meaſure of knowledge, and the practice of thoſe graces and virtues, that fit a man to glorify God in this ſhort life, and to be glorified by him in that which ſhall have no end.

## MEDITATION X.

### *Upon a thief in a candle.*

THE ſilence of the night, and my being unable to ſleep, diſpoſing me to have my attention very eaſily excited; I chanced to take notice, that the dim light of the candle, which the curtains were not drawn ſo cloſe as to exclude every where out of the bed, was on a ſudden conſiderably increaſed, and continued ſo long in that condition, that, for fear of ſome miſchance, I put my head out of the bed to ſee, whence it was that this new and unexpected increaſe of light proceeded; but I quickly found, that it was from a thief (as they call it) in the candle, which by its irregular way of making the flame blaze, had melted-down a good part of the tallow, and would have ſpoiled the reſt, if I had not called to one of thoſe, that watched with me, to reſcue the remains by the removal of the thief. But I had ſcarce done this, when, I confeſs to you, *Sophronia*, I found my ſelf invited to make ſome reflections upon what I had done, and to read my ſelf a new leſſon by the beams of this new light. For though this thief made the candle ſhine more ſtrongly, and diffuſe a much greater light than it did before; yet becauſe it made a great and irregular waſte of the candle, I ordered it to be taken away; and on this occaſion methought I might juſtly make uſe of that ſaying of *Pharaoh*'s forgetful butler, *I do remember my faults this day:* For though I find no great difficulty in abſtaining from other kinds of intemperance, yet to that of ſtudying, my friends, and eſpecially my phyſicians, have often accuſed me of being too indulgent. Nor can I altogether deny, but that in mental exerciſes there can be exorbitancies, and exceſſes, I may have ſometimes been guilty of them; and that the things, for which I think life valuable, being the ſatiſfaction, that accrues from the improvement of knowledge, and the exerciſe of piety, I thought it allowable, if not commendable, to conſume or hazard it for the attainment of thoſe ends; and eſteemed ſickneſs more formidable for its unfitting me to learn, and to teach, than for its being attended with pain and danger; and looked upon what it made me forbear, as far more troubleſome than whatever elſe it made me endure. But I find my body is a jade, and tires under my mind, and a few hours fixed contemplation does ſenſibly ſo ſpend my ſpirits, as to make me feel my ſelf more weary than the riding poſt for twice as many hours has ever done. Wherefore, ſince, though the proper uſe of a candle be to conſume it ſelf, that it may give others light, I yet thought it fit to have the thief taken away, becauſe, though it made the candle give more light, it would have waſted it too faſt, and conſequently made it expire too ſoon. I ſee not how I can reſiſt their perſuaſions, that would have me huſband better the little ſtock of ſtrength nature has given me; and the rather, by a moderate expence of it, endeavour to make it ſhine longer, though but dimly, than conſume it too faſt, though for a while to keep up a blaze: I will therefore endeavour to learn

Gen. xli. 9.

of this ſickneſs, and of this accident, what the doctors hitherto could never teach me, and enjoin my ſelf an abſtinence, which to me is more uneaſy, than if wine, or women, or other ſenſual pleaſures were to be the objects of it; but if in ſo difficult an exerciſe of ſelf-denial, I do not always perform what I am now perſuaded to, it is like I ſhall eaſily forgive my ſelf, for but a little haſtening the end of my life to attain the ends of it.

## MEDITATION XI.

### *Upon the being in danger of death.*

I Know, that phyſicians are wont, after their maſter *Hippocrates*, to tell us, that fevers which intermit are devoid of danger. But though an ague, whilſt it continues ſuch, could not be a mortal diſeaſe; yet why may it not degenerate into ſuch a one? And for my part, who take the prognoſticks of phyſicians to be but gueſſes, not prophecies, and know how backward they are to bid us fear, till our condition leave them little hopes of us; I cannot but think that patient very ill adviſed, who thinks it not time to entertain thoughts of death, as long as his doctor allows him any hopes of life: for in caſe they ſhould both be deceived, it would be much eaſier for the miſtaken phyſician to ſave his credit, than for the unprepared ſinner to ſave his ſoul.

Wherefore, *Sophronia*, finding my diſeaſe attended with unuſual threatening ſymptoms, not knowing where they would end, I laſt night thought it fit to ſuppoſe they might end in death: and two things eſpecially made me the more ready for ſuch an entertainment of my thoughts.

One, That we can ſcarce be too careful and diligent in fitting our ſelves for the acting of a part well, that we can never act but once: for where the ſcripture tells us, *it is appointed for all men once to die*; it is immediately ſubjoined, that *after that comes judgment*; and if we die ill once, we ſhall never be allowed to die again, to ſee if we would die better the ſecond time than we did the firſt: but as the wiſe man allegorically ſpeaks, *Where the tree falls, there ſhall it lie.* So that the faults committed in this laſt and importanteſt of human actions, being irreparable, I think the only ſafe way is to imitate him, who, having ſaid, *If a man die, ſhall he live again?* preſently annexed by way of inference and reſolution, *All the days of my appointed time will I wait till my change come.*

The other conſideration, that recommended to me the thoughts of the grave, was this, that we may be often ſollicitous to provide againſt many evils and dangers, that poſſibly may never reach us; and many endure, from the anxious fears of contingent miſchiefs, that never will befall them, more torment, than the apprehended miſchiefs themſelves, though really ſuffered, would inflict. But death will ſooner or later infallibly come, and never finally deceive our expectations; and therefore the forethoughts of it are an employment, which may prove, we know not how ſoon, of uſe, and will (however) prove of excellent advantage: the frequent meditation of the end of our lives, conducing ſo much to make us lead them well, that the expectation of death brings not leſs advantages to thoſe that eſcape the grave, than thoſe that deſcend into it.

Such like conſiderations, *Sophronia*, having put me upon the thoughts of death, I preſume you may have ſome curioſity to know what theſe thoughts were; and therefore, though I have neither fitneſs, nor inclination to mention to you thoſe, that almoſt every ſober perſon would have upon a death-bed, as a man, and as a Chriſtian, I will only take notice to you of thoſe few, that were ſuggeſted to me, by the leſs general circumſtances of my condition. And I am the more willing to ſatisfy your curioſity now, becauſe I have my ſelf been very inquiſitive on the like occaſion: for the approach of death will (if any thing can) make men ſerious and conſiderate; being for good and all to go off the ſtage, they make a truer and ſincerer judgment of the world they are ready to leave, and then have not the wonted partiality for the pleaſures and profits of a life they are now abandoning. And as the mind looks with other eyes upon the world, when death is ready to ſhut thoſe of the body; ſo men are then wont as well to ſpeak their thoughts more frankly, as to have them better grounded: death ſtripping moſt men of their diſſimulation, as well as of other things it makes them part with; and indeed it is then high time for the ſoul to put off her diſguiſes, when ſhe is ready to put off the very body it ſelf.

ONE thing then, that I was conſidering, *Sophronia*, was, in how wretched a condition I ſhould now be, if I had been of the ſame mind with the generality of thoſe, who are of the ſame age with me: for theſe preſume, that youth is as well made for pleaſures as capable of them, and is not more a temptation to vanity, than an excuſe for it. They imagine themſelves to do a great matter, if, whilſt youth laſts, they do ſo much as reſolve to grow better when it is gone; and they think, that for a man to be otherwiſe than intentionally religious before his hair begin to change colour, were not only to loſe the privileges of youth, but to incroach upon thoſe of old age. But alas! how few are deſtroyed by that incurable diſeaſe, in compariſon to thoſe that die before they attain it? And how little comfort is it upon a death-bed, to think, that by the courſe of nature, a man might have lived longer, when that very thought might juſtly prove diſmal to an unprepared man, by ſuggeſting to him, that this early death may argue the meaſure of his iniquities exceeding great, and that this untimely end is not ſo much a debt due to nature, as a puniſhment of ſin? All the fruition of theſe deluding pleaſures of ſin cannot countervail the horror, that a dying man's review of them will create, who not only ſees himſelf upon the point of leaving them for ever, but of ſuffering for them as long. And on the contrary, the review of youthful pleaſures declined for virtue's or religion's ſake will afford a dying man far higher joys, than their fruition would ever have afforded him.

## MEDITATION XII.

### *Upon the ſame ſubject.*

AND one thing more there is, *Sophronia*, that I dare not conceal from you, how much cauſe ſoever I have to bluſh at the diſcloſing it; and it is, that I judge quite otherwiſe of a competent preparation for death now I am near it, than I did when I was in health. And therefore, if one, that, ſince his conſcience was firſt thoroughly awakened, ſtill reſolved to be a Chriſtian, and though he too often broke thoſe good reſolutions, never renounced them, but tripped and ſtumbled in the way to heaven, without quitting his purpoſe of continuing in it, finds a formidableneſs in the approach of death: how uncomfortable muſt that approach be to thoſe, that have ſtill run on in the ways of ſin, without once ſo much as ſeriouſly intending to forſake them? A youth free from ſcandal, and ſometimes productive of practices, that were ſomewhat more than negative piety, is not ſo frequent among thoſe, that want not opportunities to enjoy the vanities and pleaſures of the world, but that the charity of others being ſeconded by that great inward flatterer ſelf-love, made me imagine, that I was in a condition fitter to wiſh for death, than to fear it. But now I come to look on death near at hand, and ſee beyond the grave, that is juſt under me, that bottomleſs gulph of eternity; methinks it is a very hard thing to be ſufficiently prepared for a change, that will tranſmit us to the bar of an omniſcient judge, to be there doomed to an endleſs ſtate of infinite happineſs or miſery. There is no art of memory like a death-bed's review of one's life; ſickneſs, and a nearer proſpect of death, often makes a man remember thoſe actions, wherein youth and jollity made him forget his duty; and thoſe frivolous arguments, which when he was in health, and free from danger, were able to excuſe him to his own indulgent thoughts, he himſelf will ſcarce now think valid enough to excuſe him unto God, before whom, if the ſinleſs angels cover their faces, ſinful mortals may juſtly tremble to be brought to appear. When the approach of death makes the bodily eyes grow dim, thoſe of the conſcience are enabled to diſcern, that as to many of the pleas we formerly acquieſced in, it was the prevalence of our ſenſes, that made us think them reaſon: and none of that jolly company, whoſe examples prevailed with us to join with them in a courſe of vanity, will ſtand by us at the bar to excuſe the actions they tempted us to. And if they were there, they would be ſo far from being able to juſtify us, that they would be condemned themſelves. It is true, *Sophronia*, if we conſider death only as the concluſion of life, and a debt all men ſooner or later pay to nature; not only a Chriſtian, but a man, may entertain it without horror: but if one conſider it as a change, that after having left his body to rot in the grave, will bring his ſoul to the tribunal of God, to anſwer the miſcarriages of his whole paſt life, and receive there an unalterable ſentence that will doom him to endleſs and inconceivable joys, or everlaſting and inexpreſſible torments; I think it not inconſiſtent either with piety or courage, to look upon ſo great a change with ſomething of commotion: and many, that would not fear to be put out of the world, will apprehend to be let into eternity.

## MEDITATION XIII.

### *A further continuation.*

ANOTHER thing, *Sophronia*, which my preſent ſtate ſuggeſted to me, was a reflection on the great miſtake of thoſe, that think a death-bed the fitteſt and opportuneſt place to begin repentance in: but ſure theſe men are very little acquainted, either with the diſadvantages of a dangerous ſickneſs, or the nature of repentance. It is true, that ſin and death do more eaſily frighten one, when they are looked on as both together; but I much doubt, whether the being frighted by hell be ſufficient to give a man a well-grounded hope of heaven: for when we ſee ſin and torment at one view, and ſo near one to another, it is not ſo eaſy to be ſure, which of the two it is, that, as we preſume, ſcares the ſinner towards heaven. And ſurely repentance, which ought to be the change of the whole man, and in ſome ſenſe the work of the whole life, is very improperly begun, when men have finiſhed that courſe, which it ſhould have guided them in: nor have men cauſe to preſume, that when God is ſeverely puniſhing them for their ſins, he will vouchſafe them ſo great a grace as that of repentance, which they would none of, till it could not make them ſerviceable to him. And as for the opportunity, it is hoped an expiring ſtate may give men for repentance, they muſt needs be great ſtrangers to great ſickneſſes, that can promiſe themſelves ſo unlikely a matter. Who can ſecure them, that the acuteneſs of the diſeaſe will not invade the brain? And as deliriums and phrenſies are not unfrequent in fevers, and other acute diſeaſes; ſo in caſe they happen to perſevere, the wretched patient is caſt into a deſperate condition, even on this ſide the grave, and as near as the body is to its diſſolution, the man may be dead a pretty while before it.

BUT ſuppoſing he eſcape theſe accidents, which make repentance impoſſible, a dangerous ſickneſs has other circumſtances enough to make it very uneaſy: for the organical faculties of the mind cannot but be dulled and prejudiced by the diſcompoſure of the ſpirits, by which their functions are to be exerciſed; and the ſenſe of pain, the troubleſome preſcriptions of phyſicians, the loathſome and bitter potions, the weakening operation of phyſick, the languiſhments produced by want of ſpirits, the reſtleſſneſs proceeding from heat and want of ſleep, the diſtracting importunity of thoſe intereſted perſons, eſpecially if any of them be ſuſpected to hover about the dying man's bed, as birds of prey, that wait for a carcaſe; the ſighs and tears of friends and relations, that come to take their laſt farewell, and to imbitter it; the lawyer, that muſt be directed to draw up the will; the divine, that muſt be allowed to ſay ſomething concerning the ſoul; and the affrighted conſcience, that alone brings more diſquiet than all the reſt put together; do make a dying man's condition ſo amazing, ſo diſmal, and ſo diſtracting, that to think this an opportune time to begin ſuch a work, (which may well enough imploy the whole man in his calmeſt ſtate of mind) is a madneſs as great as any, that even a death-bed can, by the tranſlation of the humours into the brain, occaſion. For my part, I think it ſo wild, and ſo unadviſeable a thing to put off the beginning to provide all graces to a death-bed, that I think it uneaſy enough ſo much as to exerciſe *then* thoſe that were acquired *before*; men being in that ſtate commonly unable ſo much as to reap the conſolation they have been ſowing all along a pious life.

AND this, *Sophronia*, brings into my mind a conſideration, which being taken from the very nature of a death-bed repentance, ſhould, methinks, very much deter men from reſolving beforehand to rely on it; and it is this, that granting thoſe (Socinians, and others) to be miſtaken, that think ſo late a repentance to come too late to be available; yet the dying ſinner, though he may be kept from deſpair of paſſing to heaven, can ſcarce in an ordinary way have a comfortable aſſurance of getting thither; for though it be ſaid, that a true repentance cannot come too late, yet it is a hard thing to be certain, that ſo late a repentance is true. Since repentance confeſſedly importeth an abandoning and renouncing of ſin, at leaſt in hearty purpoſe and reſolution; it is very difficult for an habitual ſinner, that remembers what vows and purpoſes of change of life, ſickneſſes or dangers have formerly induced him to make, which were forgotten, or violated, when the apprehenſions that occaſioned them were over; it is hard, I ſay, for ſuch a one to be ſure, that his preſent repentance is not of the ſame ignoble and uncurrent kind, ſince he has no experience to ſatisfy him, that it would be ordinarily, though not conſtantly, prevalent over the oppoſite temptations; and ſince alſo (which is mainly to be conſidered) it is ſo eaſy for a man to miſtake for the true hatred of ſin, and the love of God, a horror of ſin ſpringing from the preſent painful ſenſe of the miſchief procured by it, together with the great fear of the approaching torments that it threatens, and a ſtrong deſire of going to heaven, when ſeeing himſelf unable to ſtay any longer on earth, he muſt get thither to eſcape hell. And as it is thus difficult, when a man already feels much puniſhment for ſin, and ſees himſelf in danger of more, to diſcern clearly upon what account it is, that he is ſorry for what he has committed; ſo it muſt be certainly a ſtate unſpeakably anxious and uncomfortable to find one's ſelf dragged to the grave, without knowing, whether the laſt trumpet ſhall call him thence to heaven, or to hell. And if he ſhould be deceived in judging of the validity of his repentance, the fatal error would be remedileſs, and the miſtake far ſadder and more horrid than that of the Syrians, who, when they thought they were arrived victorious at *Dothan*, found themſelves at the mercy of their enemies in *Samaria*, 2 Kings vi. 18. To conclude, *Sophronia*, he, that reſolves not to renounce his ſins, till he thinks Chriſt ready to renounce him for them, may very probably loſe his ſoul, and has moſt certainly loſt his ingenuity; and that will appear a very ſad loſs for a man, that being by death denied the opportunities of actually leading a new and pious life, muſt derive his comfort from the aſſurance, that he ſincerely intends it.

## MEDITATION XIV.

### *Upon the apprehenſions of a relapſe.*

I HAVE now at length, *Sophronia*, by the goodneſs of God, regained that meaſure of health, which makes the doctor allow me to return to my former ſtudies, and recreations, and diet; and in a word, to my wonted courſe of life: ſo that the phyſician having diſmiſſed himſelf, nothing ſeems more ſeaſonable and pertinent to my preſent condition, than that of our Saviour to the paralytick man, to whom he gave both recovery, and an admonition, which, if he obeyed, he found the more advantageous of the two; *Behold, thou art made whole; ſin no more, leſt a worſe thing come unto thee.* But I am not ſo free from the apprehenſions of an ague, as my friends think me from the danger of it: for having ſadly experienced the uneaſineſs of ſickneſs, I am thereby brought, though at no eaſy rate, to ſet a high value upon health, and be a very jealous preſerver of ſo great a bleſſing; and thoſe petty chilneſſes, that formerly I regarded not, but was apt to impute to nothing but fumes of the ſpleen, or melancholy vapours, are now able to give me hot alarms, and make me apt to fancy them the fore-runners, if not the beginners, of the cold fit of an ague, the firſt invaſion of that diſeaſe having been preceded by the like diſtempers; and accordingly, I carefully avoid the leaſt irregularities in point of diet, or of any other kind, that may any ways endanger a relapſe into the diſeaſe, that once handled me ſo ill. But why ſhould I be more apprehenſive for my body than my mind? and if at any time (as it may but too often happen) any ſin ſhould come to be prevalent in my mind, why ſhould I not be ſollicitouſly afraid of all the occaſions and approaches of it, and tremble at theſe commotions of the appetite, which would not elſe perhaps be formidable to me, in caſe I have found that ſuch beginnings indulged or neglected have ended in actual ſin, the real diſeaſe of the ſoul? And as dangerous ſickneſſes do for the moſt part leave a crazy diſpoſition behind them, which threatens relapſes; ſo ſins once prevalent, though afterwards ſuppreſt, do yet leave behind them a ſecret diſpoſition or propenſity to the reception of the ſame faults. And as it is leſs difficult to find examples of bodily diſeaſes, than of ſpiritual ones, where the patient is protected from relapſes; ſo I think we ſhould be more watchful againſt falling back into the ſins, than into the ſickneſſes, we have once found our ſelves ſubject to, unleſs we ſhould think, that a greater danger, and of a nobler part, deſerved leſs of our care.

## MEDITATION XV.

### *Upon his reviewing and tacking together the ſeveral bills, filed up in the apothecary's ſhop.*

EITHER my curioſity, *Sophronia*, or my value of health, has made it my cuſtom, when I have paſſed through a courſe of phyſick, to review the particulars it conſiſted of; that taking notice by what remedies I found moſt good, and by what, little or none; if I ſhould fall into the like diſtemper for the future, I might derive ſome advantage from my paſt experience. In compliance with this cuſtom, as I was this day reviewing and putting together the doctor's ſeveral preſcriptions ſent me back by the apothecary; Good God! ſaid I, in my ſelf, what a multitude of unpleaſant medicines have I been ordered to take! the very numbering, and reading them, were able to diſcompoſe me, and make me almoſt ſick, though the taking of them helped to make me well. And certainly, if when I was about to enter into a courſe of phyſick, all theſe loathſome medicines, and uneaſy preſcriptions, had been preſented to me together, as things I muſt take, and comply with, I ſhould have utterly deſpaired of a recovery, that muſt be ſo obtained, and ſhould not perhaps have undertaken ſo difficult and tedious a work, out of an apprehenſion, that it would prove impoſſible for me to go thorough with it. Thus when a man conſiders the duties, and the mortifications, that are requiſite to a recovery out of a ſtate of ſin into a ſtate of grace, he muſt be reſolute enough, if he be not deterred from undertaking the conditions, that piety requires, by ſo many and great difficulties, as will preſent themſelves to his affrighted imagination. But let not this make him deſpondent; for it is true, that theſe diſcompoſing medicines, if I muſt have taken ſo much as a tenth part of them in one day, would have either diſpatched me, or diſabled me to endure the taking any the next. But then, although I now ſee theſe troubleſome preſcriptions all at once, I did not uſe them ſo, but took only one or two harſh remedies in one day, and thereby was enabled to bear them, eſpecially being aſſiſted by moderate intervals of reſpite, and ſupported both by other ſeaſonable cordials, and by that higheſt cordial, the hope, that the uſe of theſe troubleſome means of recovery would ſoon free me from the need of them. And thus, though the hardſhips of piety are, by the ghoſtly and carnal enemies of it, wont to be repreſented to one that begins to grow a convert, ſo great and formidable a multitude as to be inſuperable; yet if he conſiders, that though his foreſight meet with them all at once, yet he will need to grapple with them but one after another, and may be as well able to overcome a temptation this day, or to-morrow, as he did another yeſterday: ſo that to this caſe alſo may in ſome ſenſe be applied that (either counſel, or precept) of our Saviour, not to be ſollicitous for to-morrow, but to charge no more upon a day than the trouble that belongs to it. And if he conſiders too, that as a wiſe phyſician has always a great care, that his remedies be not diſproportionate to the patient's ſtrength, and after harſh phyſick to relieve him with cordials; ſo God will not ſuffer thoſe, that intruſt themſelves to him, to be tempted above what they are able, but will allow them cordials after their ſufferings, in caſe he do not turn the ſufferings themſelves into cordials. If, I ſay, our new convert ſhall conſider things of this nature, he will not be much diſcouraged by the appearance of difficulties, that will as much ennoble and indear his ſucceſs, as they can oppoſe it; and he will never deſpair of victory in an engagement, where he may juſtly hope to have God for his ſecond, and heaven for his reward.

# OCCASIONAL REFLECTIONS.

## SECT. III.

### REFLECTION I.

*Upon the ſight of ſome variouſly-coloured clouds.*

THERE is amongſt us a ſort of vain and flanting grandees, who for their own unhappineſs, and their age's, do but too much reſemble theſe painted clouds; for both the one and the other are elevated to a ſtation, that makes moſt men look upon them, as far above them; and their conſpicuouſneſs is often increaſed by the bright ſunſhine of the prince's favour, which, though it really leaves them creatures of the ſame frail nature, that it found them of, does yet give them a luſtre and a gaudineſs, that much attracts the eye, and perhaps the envy and reſpect of thoſe ſuperficial gazers upon things, that are wont to be amuſed, if not dazzled, with their inſignificant outſides. But the parallel holds further; for as, in ſpite of theſe clouds' ſublimity and conſpicuouſneſs, they are but airy and unſolid things, conſiſting of vapours, and ſteered by every wind: ſo the fine people I am comparing them to, in ſpite of their exaltation, and of all the ſhew they make, are really but ſlight perſons, deſtitute of intrinſick and ſolid worth, and guided either by their own blind luſts and paſſions, or elſe by intereſts as fickle as thoſe, (to which it will be no addition to ſay) or as variable as the wind. And as theſe clouds, though they ſeem vaſt as well as high, and are perhaps able, for a while, to make the ſky ſomewhat dark, have uſually but a ſhort duration, and either quickly fall down in rain, or are quite diſſipated, and made to diſappear; ſo thoſe titled perſons, what ſhew ſoever their greatneſs makes, do oftentimes, either by a voluntary humility and repentance, as it were, deſcend of their own accord, and, by doing of good, endeavour to expiate and make amends for their former uſeleſſneſs, if not miſchiefs; or elſe, after having been a while ſtared at, they do (ſome of them more ſlowly, and ſome more abruptly) vaniſh, without leaving behind them any thing that can ſo much as entertain our ſight in the very place, where before they engroſſed it: and this ruin ſometimes happens to the moſt elevated perſons, from that very prince, whoſe favour made them attract ſo many eyes; as clouds are oftentimes diſperſed before night by the ſame ſun, that had raiſed and gilded them in the morning.

### REFLECTION II.

*Upon his making of a fire.*

HOW many fruitleſs blaſts have I been ſpending upon this ſullen fire! It was not, though, the greenneſs of this wood, that made it ſo uneaſy to be kindled; but, it was alone the greatneſs of the logs, on which the fire could take no hold, but by the intervention of ſuch ſmaller ſticks as were at firſt wanting here: witneſs, that I had no ſooner laid on a little bruſhwood, but the flame from thoſe kindled twigs, invading and prevailing on the billets, grew ſuddenly great enough to threaten to make the houſe it ſelf part of its fuel, and turn it to ſuch aſhes, as it makes haſte to reduce the wood into. Methinks the blaze of this fire ſhould light me to diſcern ſomething inſtructive in it: theſe blocks may repreſent our neceſſary; theſe ſticks our leſs important, religious practices; and this aſpiring flame, the ſubtile inhabiter of that of hell. It will be but ſucceſsleſly, that the devil can attempt our grand reſolves, till he have firſt maſtered our leſs conſiderable ones; and made his ſucceſſes againſt theſe, not only degrees, but inſtruments, in the deſtroying of the other: our more neglected and ſeemingly trivial affections, having once received his fiery impreſſions, do eaſily impart them to higher faculties, and ſerve to kindle ſolider materials. It is therefore the ſafeſt way, to be faithful even to our leſſer determinations, and watchful over our leſs predominant paſſions; and whenſoever we find our ſelves tempted to violate the former, or neglect the latter, not ſo barely to caſt one eye upon the ſeeming inconſiderableneſs of what we are inticed to, as not to fix the other upon the conſequences that may attend it; and therein, to conſider the importance of what ſuch ſlighted things may, as they are managed, prove inſtrumental, either to endanger, or to preſerve.

## REFLECTION III.

### *Upon my ſpaniel's carefulneſs not to loſe me in a ſtrange place.*

DURING my ſtay at home, whilſt every-body this cur chanced to meet, made ſo much of their landlord's ſpaniel, that they ſeemed to have added to oracles that proverb of *Love me, love my dog*, the cajolled cur would never keep at home; but being welcomed to ſo many places abroad, made me few viſits, that coſt me not the trouble of ſending for him. But now, that we are in a place, where he ſees no more men than ſtrangers, he ſtirs not from my heels, and waits ſo cloſe, and carefully, that it were now more difficult to loſe him, than it was formerly to keep him from wandering. Thus doth it generally fare with us; whilſt we are environed with numerous outward objects, which, ſmiling on us, give our gaddings to them, the temptation of an inviting welcome; how inclined are we to forget and wander from our great maſter? But when we are deprived of thoſe inveigling courtiers, our Maker too is freed from thoſe ſeducing rivals, and our undiſtracted affections are brought to ſettle on their nobleſt object, by the removal, and the diſplacing, as well as they would be by the knowledge and the undervaluation, of inferiour ones. Lord! when I loſe a friend, or any outward idol of my fondneſs, teach me to reduce him to leave thee his heir, by taking that loſs for a ſummons, to transfer and ſettle my whole love on thee: and if thou but vouchſafe to make me ſo happy, I ſhall think my ſelf enough ſo, not to envy him, to whom the loſs of his aſſes proved an occaſion of his finding a crown; and ſhall not ſo much regret what thy diſpenſations ſhall have taken from me, as gratulate to my ſelf their having reduced me unto thee.

## REFLECTION IV.

### *Upon the prodigiouſly wet weather, which happened the ſummer that* Colcheſter *was beſieged.* (1648.)

HOW ſtrangely unſeaſonable is this melancholy weather! and how tedious a winter have we endured this ſummer? More than theſe few laſt weeks have not afforded us half as many days, wherein we were neither troubled with ſhowery, or threatened by cloudy weather; and we in *England* have great temptations to envy nature's kindneſs unto *Rhodes* *, if it be true what geographers relate of that iſland, that it is a rarity for the inhabitants to ſee a day paſs without their ſeeing the ſun: for, among us, the confuſions of our country ſeem to have infected our very air, and ſerenity is as great a rarity in the ſky, as in men's conſciences; ſo that thoſe, who are wont to make fires, not againſt winter, but againſt cold, have generally diſplaced the florid, and the verdant ornaments of their chimneys, and think *Vulcan* more proper there than *Flora*; and ſome begin to doubt, whether our almanacks be not miſtaken, by calling this month *July* inſtead of *November*. But notwithſtanding all this appearance of winter above our heads, yet whilſt we ſee, that cherries and ſtrawberries, and other ſummer fruits, do grow, and, though but ſlowly, make a progreſs towards maturity in our orchards, we doubt not that it is ſummer, and expect, that theſe fruits, though they will not be early ones, will at length come to be ripe ones.

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* At *Rhodes* the air is never ſo dim and cloudy, but one hour or other the ſun ſhineth out. *Pliny, l.* 2. *c.* 62. Where he alſo ſays the ſame of *Syracuſa*.

THUS, for reaſons, which, though we know not yet, our knowing of God may aſſure us to be both wiſe, and juſt, a pious ſoul may ſometimes be reduced to ſo ſad a condition, that the face of heaven does to her appear perpetually overcaſt; and the tokens of God's diſpleaſure do ſo cloſely follow one another, that, to borrow *Solomon*'s phraſe, *The clouds return after the rain.* But if, notwithſtanding all this, the ſeemingly deſerted ſoul, do, like the good ground mentioned in the goſpel, bring forth fruit with perſeverance; if prayer, charity, reſignation, and thoſe other divine graces, that are wont to be the proper and genuine productions of God's ſpirit, do flouriſh, and proſper in the ſoul, we may ſafely conclude that ſoul, though never ſo diſconſolate, to be in the ſtate of grace, and that ſhe really receives the bleſt aſſiſtances of him, who can alone give the increaſe (to the ſeeds of piety and virtue) though not in the glad and conſpicuous way of an unclouded heaven, yet in the effectual, though ſecret, method of fructifying influences; and we may reaſonably hope, that he, that has not only begun a good work, but carried it on thorough ſuch impediments, and diſadvantages, will perfect it, by bringing the ſlow, but yet gradually, ripening fruit to the due perfection: for thoſe, that are the humble Chriſtian's proper graces, do ſo much depend upon the author, that, if they flouriſh, his hiding himſelf in clouds need not make us doubt the fruits we ſee, to be the productions of the Sun of righteouſneſs, though we ſee him not. We muſt not haſtily conclude it winter with the ſoul, though the heaven be lowering, provided the earth be fruitful; but remember, that the ſaving influence of God's ſpirit may be, where his comfortable preſence is not perceived: the living in ſenſible comforts and joys is rather a part of our reward, than of our duty; and that (conſequently) it may ſave many modeſt and pious perſons a great deal of diſquiet, if they would learn to judge of their ſpiritual condition, rather by the duties, and ſervices, they pay God, than by the preſent conſolations he vouchſafes them; or, in a word, rather by what they do, than by what they feel.

## REFLECTION V.

### *Upon his being carved to at a feaſt.*

THOROUGH many hands hath this plate paſſed, before it came to mine; and yet, though I bowed to every one of thoſe that helped to convey it, I kept my chief and ſolemneſt acknowledgment for the fair lady that ſent it. Why ſhouldeſt thou not, O my ſoul, inſtruct thy gratitude to tread in the ſteps of thy civility? When thou receiveſt any bleſſing from *that Father of lights, from whom every good and perfect gift comes down*, pay a fitting ſhare of thy thanks to them, that hand it to thee; but thorough all thoſe means, look principally to that God, that ſends it. Let not the pipe uſurp upon the ſpring, (that were as abſurd, as it were for me to kiſs my hand to the plate, or at beſt, to thoſe that helped to convey it, with a neglect of the lady) but ſo pay thy due acknowledgments to the reachers, that thou be ſure to reſerve thy principal thanks, and higheſt ſtrains of gratitude, for the giver.

## REFLECTION VI.

*Upon the ſight of a looking-glaſs, with a rich frame.*

**Eugenius, Lindamor, Euſebius.**

*Lind.* THIS glaſs has a frame ſo curious, and ſo rich, that though I could ſcarce, if I would, withhold my eyes from gazing here; yet, I believe, the operation it has on my curioſity, is no more than what it generally has on that of others; and by the attention, with which I ſaw, even you, gentlemen, ſurvey it, I am eaſily perſuaded, that one needs not be a lady, not to paſs by ſuch a looking-glaſs without repairing to it.

*Eug.* I am much of your opinion, *Lindamor*; and ſuch a ſight as this has often made me a greater friend, than many ſeverer perſons are, to eloquence in ſermons: for as if this very glaſs had been placed here in a mean or common frame, it would ſcarce have ſtopped us in our paſſage through the room, or have invited us to conſult it; ſo a ſermon may, by the nicer ſort of auditors, be left unregarded, though it be for ſubſtance excellent: when as the frame, though it be not part of the glaſs, nor ſhews us any part of our faces, does yet, by its curious workmanſhip, attract our eyes, and ſo invite us to conſult the glaſs, that is held forth in it; ſo the wit, and fine language, wherein it is dreſſed up, though it be no eſſential or theological part of the ſermon, yet it is often that, which invites men to hear, or read it.

*Lind.* I think indeed, *Eugenius*, that wit and eloquence do highly recommend ſermons, and devout compoſures, to the curioſity and attention of ſome, that elſe would ſcarcely mind them; and upon that account, I allow of your compariſon: but give me leave to carry it on a little further, by obſerving, that as the curious frame doth as well pleaſe, as attract, the eye, without repreſenting to it the lively image of the beholder's face; ſo the fine expreſſions you applaud, are commonly parts of a ſermon, that have no ſpecular virtue in them; I mean, that have no power, like a good looking-glaſs, to acquaint the beholder with the true image or repreſentation of his own complexion, and features: nor will this gaudy frame ſhew him what is otherwiſe than it ſhould be; the diſcovery of which, nevertheleſs, in order to the rectifying what is amiſs, is the principal and genuine uſe of a looking-glaſs. And therefore, as no ſkilful man will judge of the goodneſs of a glaſs, by the fineneſs of the frame, but rather by its giving him a true repreſentation of his face, without liking it the worſe, for ſhewing him its moles, and warts, or other blemiſhes, if it have any; ſo no wiſe Chriſtian will judge of a rouſing ſermon, rather by the language, than the divinity, or will think the worſe of a good book, for diſcovering his faults, or making him think the worſe of his own, or other men's ill courſes.

*Euſeb.* Let me add, gentlemen, that as when a glaſs has a rich and gaudy frame, children's eyes are oftentimes ſo entertained and amuſed with it, that they are regardleſs of any thing elſe; and for the ſake of that part, which they can but ſee, they are unmindful to conſult that uſefuller part, whoſe office it is to diſcover to them, themſelves:

ſelves: ſo, when there is too much of rhetorick in a ſermon, many, that ſhould not be children, have attention, not only ſo attracted, but ſo detained, by that, that they are not thereby invited to conſult, but diverted from regarding, the more inſtructive part of the diſcourſe. And the more witty and critical ſort of auditors, are ſo much more accuſtomed to judge of ſermons, than to judge of themſelves by them, that they deal with them, as if, in this glaſs, a man ſhould only praiſe or diſcommend the workmanſhip of the imboſſed images of the frame, without caring to make uſe of the glaſs itſelf, to mend any thing he finds out of order about him. For thus, theſe faſtidious and cenſorious hearers make no other uſe nor repetition of ſermons, than to cenſure or applaud the expreſſions, and contrivances, (which ſhould be looked upon but as the ornaments of it) without minding the doctrine, or caring to amend what that has diſcovered to be amiſs in them. But it muſt be confeſt, though I muſt grieve and bluſh, it can be truly ſo, that it is but too often, as the ſcripture ſomewhere complains, *like people, like prieſt*; and that there is a ſort of preachers, and thoſe of the moſt celebrated, who take a courſe more likely to encourage, than reform, ſuch hearers; and which would, perhaps, make men ſuch, if it did not find them ſo: for one of this ſort of preachers (for I am loth to call them divines) appears more ſollicitous to make his expreſſions, than to make his hearers, good. And whereas, theſe, that are concerned for the winning or the ſaving of the ſouls, think it a leſs ſure ſign of a good ſermon, that it makes the hearers applaud the preacher, than that it makes them condemn themſelves; the orator I am mentioning, had much rather hear their praiſes than their ſighs; and, accordingly, is more ſollicitous to tickle their ears, than, how much need ſoever there be of it, to launce their conſciences. He may, with far more truth than piety, invert the profeſſion of St. *Paul*, and ſay, that he preaches *not Chriſt crucified, but himſelf*; and though now and then he ſeem very vehemently to declaim againſt vices, yet one may eaſily enough perceive, that it is but a perſonated anger, and that he rather fences with ſin, than is concerned to deſtroy it, and ſpeaks againſt it rather to ſhew ſkill, than to exerciſe hatred: and as he affects to appear rather an orator than a divine, ſo he is well enough content his auditors ſhould rather admire his good language than follow his beſt counſel; and, as if all that belongs to miniſters, and their flocks, could be performed in the pulpit, and the pew, he is more careful to remember his ſermons before he has delivered them, than to keep his auditors from forgetting them afterwards; and unconcerned for their proficiency, ſeeks but their praiſes, ſcarce ever aiming at ſo much as his own diſcharge. In a word, in ſuch kind of ſermons, there is little ſpoken, either from the heart, or to the heart; the orator and the auditory tacitly agreeing to deceive themſelves; and the converſion of ſinners being neither the effect, nor the aim of ſuch florid, but unedifying diſcourſes, the buſineſs is tranſacted on both ſides, as if the preacher thought he had done his part, when he had ſhewn his wit, and the hearers thought they had done theirs, when they have commended it.

## REFLECTION VII.

### *Upon my ſpaniel's fetching me my glove.*

POOR cur! how importunate is he to be imployed about bringing me this glove? and with what clamours, and how many fawnings, does he court me to fling it him? I never ſaw him ſo eager for a piece of meat, as I find him for a glove: and yet he knows it is no food for him, nor is it hunger, that creates his longings for it; for now I have caſt it him, he does nothing with it, but (with a kind of pride to be ſent for it, and a ſatisfaction, which his glad geſtures make appear ſo great, that the very uſe of ſpeech would not enable him to expreſs it better) brings it me back again; as he meant to ſhew me, he deſired not to keep it for himſelf, but only to have it in his power to return it as a preſent to his maſter. But he muſt not bring me thus an empty glove; it is in thee, my ſoul, to fill this accident with inſtruction, by learning from religion as diſintereſted a behaviour towards God, as nature taught this brute creature towards me. I will, in my addreſſes for externals, leſs earneſtly implore them for the ſervice they may do me, than for the ſervice I may do God with them; and (as princes commands are looked upon by courtiers as honours, and as favours) contenting myſelf with the ſatisfaction of being truſted, and imployed by him, I will rejoice at the liberal expreſſions of his love, as they may be improved into proportionable expreſſions of mine, and will beg no largeſs of his bounty, without a deſign of referring it to his glory.

## REFLECTION VIII.

*Upon the taking up his horſes from graſs, and giving them oats before they were to be ridden a journey.*

JUST ſo does God uſually deal with his ſervants: when he vouchſafes them extraordinary meaſures of grace, they are to look for employments that will exerciſe it, or temptations that will try it.

THUS that great *captain of our ſalvation*, Heb. xii. 2. whom the ſcripture ſo much and ſo deſervedly exhorts us to have our eyes on, when at his ſolemn inauguration into his prophetick office, the heavens were opened, from whence the ſpirit of God did in a bodily ſhape deſcend like a dove upon him, accompanied with a heavenly voice, proclaiming him the beloved ſon of God, *in whom the Father is well pleaſed*, *Matth.* iv. *Then*, I ſay, that is, (as St. *Mark* tells us) *immediately* Jeſus (*being*, as another evangeliſt has it, *full of the Holy Ghoſt*, Luke vi. 1.) was led *up of the ſpirit into the wilderneſs to be tempted of the devil.* That wiſe and merciful diſpoſer of all things, who will not *ſuffer his children to be tempted above what they are able*, ſeaſonably fortifies them by theſe preparatory proviſions and conſolations, for the labours and difficulties they are to be expoſed to. But whereas, if theſe horſes had reaſon wherewith to foreſee the journey in order whereunto the provender is ſo plentifully given them, they would (if not be troubled at their good cheer) at leaſt loſe much of the pleaſure of it, by thinking of the labour to enſue: With the ſervants of God the caſe is much otherwiſe; for ſuch is his goodneſs to thoſe he is pleaſed thus to deal with, in propoſing and reſerving them a crown in ſome ſort proportionate to, and yet ineſtimably outvaluing, the toils and difficulties requiſite to obtain it; that as advantageous and as welcome as his preparatory vouchſafements can be, the pious ſoul may well think them leſs favours upon their own account, than as they enable the receiver to do the more ſervice to the giver.

Mark i. 12.

## REFLECTION IX.

*Upon the making of a fire with charcoal.*

THOSE that luſt faſcinates are apt to imagine, that if they can ſuppreſs its viſible effects, and ſenſible heat, that will be ſufficient to free them from all the miſchiefs, they need fear from it: but luſt is ſo pernicious a gueſt, that not only he is very watchful to intrude again where he has once been entertained, but, notwithſtanding his abſence, he may continue to do miſchief to thoſe, that ſeem to have quite expelled him. For as wood, that is once thoroughly ſet on fire, may afterwards have that fire quite choaked, and extinguiſhed, and yet by thoſe changes be turned into charcoal, whereby it is not only made black, but diſpoſed to be far more eaſily kindled, and conſumed than before; ſo thoſe, who have once had their hearts thoroughly poſſeſt by the pernicious flames of luſt, (which is indeed, to imploy an inſpired expreſſion, *to be ſet on fire of hell*) even when they have ſtifled theſe criminal flames, and feel no more of their heat, may not only have their reputation irrecoverably blemiſhed by what is paſt, but commonly carry about with them an unhappy diſpoſition to be re-inflamed, and to have by a few ſparks, and a little blowing, thoſe deſtructive fires ſo re-kindled, as to rage more fatally than ever.

## REFLECTION X.

### *Looking through a priſmatical or triangular glaſs.*

THIS more than flattering glaſs adorns all the objects I look on through it, with a variety of colours, whoſe vividneſs does as much charm my ſenſe, as their nature poſes my reaſon; without the help of the ſun, and clouds, it affords me as many rainbows as I pleaſe. And not only when I look on trees, and meadows, and gardens, and ſuch other objects, that are of themſelves acceptable to the ſight; this glaſs lends them ornaments above any they are beholden for either to nature, or art: but when I caſt my eyes upon coarſer, and homely things, and even on dunghills, this favourable interpoſer preſents them to me in ſuch curious and gaudy colours, that it does not ſo properly hide their deformities, as to make them appear lovely. So that which way ſoever I turn my eyes, I find them ſaluted, as if I were in ſome rich jeweller's ſhop, with ſaphires, topazes, emeralds, and other Orient gems, the vividneſs of whoſe colours may juſtify thoſe, that think colours to be but diſguiſed light, which, by theſe various reflections, and refractions, comes to be rather dyed than ſtained.

BUT this glaſs muſt as well afford me inſtruction, as delight, and even by deceiving me, teach me: for thus ſinful Chriſtians, when God looks upon them in themſelves, muſt needs ſeem too polluted, and disfigured, not to appear loathſome to him, *who is of purer eyes than to behold iniquity* without abhorrency; but when Chriſt interpoſes betwixt his eyes and us, we then ſeem far other things than otherwiſe we ſhould, and not only we do not appear filthy, but we do appear lovely, if not glorious. And as though ſome objects, as things purely white, and flames, look better through this glaſs, than homely and dirty ones; yet even theſe, looked upon through this glaſs, are more richly adorned, than the others beheld without it: ſo, whatever difference there may be betwixt perſons, that are either innocent, or exemplary, upon the bare account of morality; and thoſe ignorant or frail children of God, that, in themſelves conſidered, would be much inferiour to thoſe newly mentioned; yet when theſe are looked upon through Chriſt, they are much more acceptable in God's eyes, than the others conſidered out of him. And I ſhall add this further, that whereas my looking upon objects through the priſm, however it makes them appear to my eyes, does work no real change in the things themſelves, but leaves thoſe, that were homely and foul before, foul and homely ſtill; God's gracious looking upon us in Chriſt makes us by degrees become fit for his goodneſs to take delight in, and has an improving and transfiguring power on us; like the ſun, that cheriſhes green and unblown flowers, and paints them with their curioſeſt colours, by his looking on them. Since then the Scripture tells us, that we are not only reconciled to God, but, if I may ſo expreſs it, are *ingratiated and endeared to him in the beloved*; how much do we owe to that bleſſed Saviour, upon whoſe account we enjoy the invaluable privilege to appear (and grow fit to do ſo) pleaſing in God's eyes? which, beſides that it is the higheſt honour, leads to the higheſt happineſs; or rather, is the one as well as the other.

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## *An Advertiſement touching the Fourth Section.*

A Reader, that is not unattentive, may eaſily collect from what he will meet with in ſome of the enſuing diſcourſes, that they were written ſeveral years ago, under an uſurping government, that then prevailed. And this may keep it from appearing ſtrange, that in papers, which contain ſome things not likely to be reliſhed by thoſe, that were then in power, the author ſhould take occaſion to ſpeak of himſelf as of another perſon; as well to avoid the being ſuſpected by them, in caſe his papers ſhould come into any of their hands, as to comply with the deſign he then had; that if theſe diſcourſes ſhould happen to be made publick, the reader might be left to gueſs, whether or no he were entertained with a fiction, or a true narrative. And though a change of circumſtances has occaſioned the publication of theſe papers, which ſhould have come forth by themſelves (if at all) in ſuch a way as will make moſt readers look upon them as containing a ſtory purely romantick; yet they may have in them much leſs of fiction, than ſuch will (it is like) imagine. For being really a great lover of angling, and frequently diverting my ſelf at that ſport, ſometimes alone, and ſometimes in company; the accidents of that recreation were the true themes, on which the following diſcourſes were not the only meditations I had made. Nor is the intimation given at the end of this (fourth) ſection, of a further continuation of ſuch diſcourſes, an artifice or ſhift, to ſteal away from a converſation I was unable to continue, without ſeeming to do ſo; there being in readineſs divers reflections relating to our anglers, which had furniſhed *Euſebius* and his friends with diſcourſes for the afternoon, if I had judged, that to invite an addition to ſo prolix an account as I had given of them already, nothing could be requiſite but a ſupply of thoughts.

# OCCASIONAL REFLECTIONS.

## SECT. IV.

### *Which treats of Angling improved to ſpiritual uſes.*

## DISCOURSE I.

### *Upon the being called upon to riſe early on a very fair morning.*

THE ſun had as yet but approached the eaſt, and my body as yet lay moveleſs in the bed, whilſt my roving thoughts were in various dreams, rambling to diſtant places; when, methought, I heard my name ſeveral times pronounced by a not unknown voice. This noiſe made me, as I was ſoon after told, half open my eyes, to ſee who it was that made it, but ſo faintly, that I had quickly let my ſelf fall aſleep again, if the ſame party had not the ſecond time called me louder than before, and added to his voice the pulling me by the arm. But though this waked me ſo far, as to make me take notice, that I was called upon to riſe, yet my drouſineſs, and my unwillingneſs to forgo a not unpleaſant dream, keeping me from diſcerning diſtinctly, who it was, that called me, made me briſkly enough bid him, whatever his buſineſs were, let me alone: but though at the ſame time I turned away my head to ſhun the light, though dim, which at the half-opened curtain ſhone in upon me, yet the party, inſtead of complying with my deſires, did by the throwing open the curtains, further let in ſo much more light upon my face, that finding it would not ſerve my turn to keep my eyes ſhut, I opened them to ſee, who it was, that gave me this unwelcome diſturbance. This I had no ſooner done, than that I perceived that it was *Euſebius*, who with *Lindamor*, and two or three other friends, was come to call me to go a fiſhing, to a place, where by appointment we were to meet about ſunriſing. The reſpect I paid *Euſebius*, and the value I placed upon his converſation, covered me with bluſhes to be thus ſurprized by him; and obliged me to ſatisfy him as well as I could, how much I was troubled and aſhamed to have the favour of his company brought me to my bed-ſide, when I ought, and intended to have waited on him. And thus, whilſt I was making him my apologies, and he was pleaſantly reproaching me for my lazineſs, and laughing at the diſorder I had not yet got quite out of, I made a ſhift haſtily to get on my clothes, and put my ſelf into a condition of attending him and the company to the river-ſide.

WHILST we were walking thither-ward, and *Lindamor* was minding *Euſebius* of the promiſe he had made the day before, to exerciſe, upon moſt of the things that ſhould occur to us, his art of making occaſional reflections, I was delighting my ſelf with the deliciouſneſs of that promiſing morning, and indeed the freſhneſs of the air, the verdure of the fields and trees, and the various enamel of the meadows, the muſick of the numerous birds, that with as melodious as chearful voices welcomed ſo fair a morning; the curious orient colours, wherewith the riſing ſun embelliſhed the eaſtern part of the ſky, and above all that ſource of light, who, though he ſhews us all, that we ſee of glorious and fair, ſhews us nothing ſo fair and glorious as himſelf, did ſo charm and tranſport me, that I could not hold expreſſing my ſatisfaction in terms, that, *Eugenius* was pleaſed to ſay, needed not rhymes to make them poetical. And the ſenſe of this invited me to add, that I now would not for any thing have miſſed being waked, and thought my ſelf hugely obliged to *Euſebius*'s freedom, that would not ſuffer me to ſleep out ſo glorious a morning, nor loſe the ſatisfaction of ſuch deſirable company.

*Euſebius*, who was but a little way off in diſcourſe with *Lindamor*, over-hearing a good part of what I had ſaid, thought fit to take thence a riſe, to begin complying with his friends requeſts; and accordingly, walking up towards me, and addreſſing himſelf to me, he told me, You are unconcerned enough, *Philaretus*, in what I am about to ſay, to make it allowable for me to tell *Lindamor*, that what has this morning happened to you, puts me in mind of what I have ſeveral times obſerved on another occaſion. For when a man is ſo lulled aſleep by ſenſual pleaſures, that, like one that ſleeps, he has but the faculty, not the exerciſe of reaſon, and takes his dreams for realities; if ſome ſerious divine, or other devout friend, concerned for the ſinner's ſoul, or his glory, that died to redeem it, endeavour to awaken him, and rouſe him out of that ſtate, wherein he lies ſo much at eaſe; ſuch attempts are wont at firſt to be looked upon by the lazy ſinner, enamoured of his eaſe, and preſent condition, but as pieces of unſeaſonable, if not uncivil officiouſneſs; and entertaining the light it ſelf but as an unwelcome gueſt, he obſtinately ſhuts his eyes againſt that, which alone makes them uſeful; and, inſtead of looking upon the attempter as his friend, he checks him, and expoſtulates with him, and uſes him almoſt as an enemy: inſomuch, that too often thoſe, that love the welfare of ſouls too little, or their own eaſe too much, forego, with their hopes, their endeavours to reclaim him. But if, by God's bleſſing, upon the conſtancy of this kindneſs, and the letting in of ſo much light upon the ſinner, that he finds himſelf unable to continue his ſlumber any longer with it, he comes to be thoroughly awaked, he quickly grows ſenſible, that he is brought out of the kingdom of darkneſs, into a true and marvellous light; and, inſtead of thoſe empty fleeting dreams, which did before amuſe and delude him, and which, to reliſh, and be fond of, the eyes of his mind muſt be as well cloſed, as thoſe of his body, he is admitted to noble, and manly entertainments, ſuch as reaſon chuſes, conſcience applauds, and God himſelf approves. And this change of his condition he finds ſo advantageous, that he would not, for all the world, return again to that, he was at firſt ſo angry to be diſſuaded from; and he does not forgive, but thank the perſon, that diſquieted him, and bluſhes at the remembrance of his having reduced others to importune him to be happy: and, betwixt ſhame and gratitude, the ſenſe of his preſent, and of his paſt condition, poſſeſſing him, how much he has reaſon, to make his reſcuer as well amends for what he endured, as retributing for what he acted for him, he does, perchance, eſpecially in the firſt fervors of his zeal, think himſelf as much obliged to his awakener, as *Philemon* was to St. *Paul*, to whom, the Scripture ſays, that he owed even himſelf. And ſometimes ſuch a new convert, as I am ſpeaking of, will think his obligation, to the inſtrument of his change, ſo ſuitable to the tranſcendent ſatisfaction he finds in the change itſelf, that he would deſpair of ſeeing his benefactor ſufficiently recompenſed, if he did not remember a ſaying of the Prophet, *(That thoſe, that turn others to righteouſneſs, ſhall ſhine as the ſtars for ever and ever)* that gives him ground to hope, that God himſelf (whoſe plenty, as well as bounty, is inexhauſted) will make the recompence his work. Wherefore, concludes *Euſebius*, if you chance to have any friends, (as it is odds moſt men have) that ſtand in need of this as great, as unwelcome, expreſſion of kindneſs, let us not be too ſoon diſcouraged, by finding the effects of our friendſhip coldly received, and poſſibly too looked upon as diſturbances; for beſides, that the leſs they are deſired, and the worſe they are entertained, the more they are needed; a Chriſtian is not bound, ſo much to concern himſelf in the ſucceſs of his endeavours, as to leave it in the power of every one that will be obſtinate, to make him unhappy, when the buſineſs, one way or other, come to an end, he may miſs his aim, without loſing his labour, ſince he ſerves a maſter, that is as ready to reward, as able to diſcern intentions; and, in caſe your endeavours do ſucceed, you will at once make a man your friend, and worthy to be ſo. And you ſhall ſcarce ever find men more affectionate to you, than thoſe you have made your friends by making them enemies to vice.

## DISCOURSE II.

### *Upon the mounting, ſinging, and lighting of larks.*

THE agreement we had made at our ſetting forth, that the motion of our tongues ſhould not hinder that of our feet towards the river-ſide, was the cauſe, that the paſt diſcourſes not having diſcontinued our walk, by that time they were ended, we began to traverſe certain ploughed lands, that lay in the way betwixt us and the river. But we had ſcarce entered thoſe fields, when our ears were ſaluted with the melodious muſick of a good number of larks, whereof ſome mounted, by degrees, out of ſight, and others, hovering and ſinging a while over our heads, ſoon after lighted on the ground, not far from our feet.

AFTER we had a while enjoyed this coſtleſs, and yet excellent muſick, both *Euſebius* and I, chancing to caſt our eyes towards *Eugenius*, obſerved, that his did very attentively wait upon the motions of a lark, that, ſinging all the way upwards, and mounting, by degrees, out of ſight, not long after deſcended, and lighted among ſome clods of earth, which being of the colour of her body, made us quickly loſe ſight of her. Whereupon *Euſebius*, who was full as willing to hear as ſpeak, and, in the occaſional reflections that he made, was wont at leaſt as much to aim at the exciting others thoughts, as the venting of his own, begged *Eugenius* to tell us what it might be, which his attentiveneſs to the motions of the lark made us preſume he was thinking on.

*Eugenius*, after a little backwardneſs, which he thought modeſty exacted of him, ſoon anſwered us in theſe terms:

AMONG all the birds, that we know, there is not any, that ſeems of ſo elevated, and, I had almoſt ſaid, heavenly a nature as the lark; ſcarce any give ſo early and ſo ſweet a welcome to the ſpringing day. And that, which I was juſt now gazing on, ſeemed ſo pleaſed with the unclouded light, that ſhe ſung as if ſhe came from the place ſhe ſeemed to go to; and during this charming ſong, mounted ſo high, as if ſhe meant not to ſtop, till ſhe had reached that ſun, whoſe beams ſo cheriſhed and tranſported her; and in this aſpiring flight ſhe raiſed herſelf ſo high, that though I will not ſay, ſhe left the earth beneath her very ſight, yet I may ſay, that ſhe ſoared quite out of ours. And yet when from this towering height ſhe ſtooped to repoſe or ſolace herſelf upon the ground, or elſe when to ſeize upon ſome worthleſs worm, or other wretched prey, ſhe lighted on the ground, ſhe ſeemed ſo like the earth, that was about her, that I believe you could ſcarce diſcern her from its clods. And whereas other birds, that fly not half ſo high, nor ſeem any thing near ſo fond of the ſun, do yet build their neſts upon trees, the lark does as well build hers upon the ground, as look like a part of it.

THUS I have known, in theſe laſt and worſt times, many a hypocrite, that when he was converſant about ſublimer objects, appeared, as well as he called himſelf, a ſaint; nothing ſeemed ſo welcome to him as new light; one might think his lips had been touched with a coal from the altar, his mouth did ſo ſweetly ſhew forth God's praiſe, and ſacred diſpenſations. In ſum, take this hypocrite in his fit of devotion, and to hear him talk, you would think, that if he had not been already in heaven, at leaſt he would never leave mounting till he ſhould get thither.

But when the opportunities of advantaging his lower intereſts called him down to deal about ſecular affairs here below, none appeared more of a piece with the earth than he, for he looked, as if he had been beſmeared all over with the earth round about him, and he ſeemed, in providing for his family, to be of a meaner and a lower ſpirit, than thoſe very men, whom in diſcourſe he was wont to undervalue, as being far more earthy than himſelf.

Since we know, ſays *Euſebius*, that the beſt things corrupted prove the worſt, it can be no diſparagement to piety, to acknowledge, that hypocriſy is a vice, which you cannot too much condemn. And when the pretending of religion grows to be a thing in requeſt, many betake themſelves to a form of religion, who deny the power of it; and ſome perchance have been preferred leſs for their *Jacob*'s voice than for their *Eſau*'s hands.

But, *Eugenius*, let us not, to ſhun one extreme, fondly run into the other, and be afraid or aſhamed to profeſs religion, becauſe ſome hypocrites did but profeſs it: his courſe is ignoble, and prepoſterous, that treads the paths of piety, rather becauſe they lead to preferment than to heaven; but yet it is more excuſable to live free from ſcandal for an inferiour end, than not to live ſo at all: and hypocrites can as little juſtify the profane, as themſelves. It may be, that all, that own religion, are not pious; but it is certain, that he, that ſcorns to own it, muſt leſs be ſo. And if ſcoffers at piety ſhould ſucceed the pretenders to it, they cannot be ſaid (as ſometimes they would be thought) to be an innocent ſort of hypocrites, that are better than they ſeem: for ſcandal is a thing ſo criminal, and contagious, that whoſoever deſires, and endeavours to appear evil, is ſo: to refuſe to be religious, becauſe ſome have profeſſed themſelves to be ſo, is to injure God, becauſe he has been injured. A ſkilful jeweller will not forbear giving great rates for necklaces of true pearl, though there be many counterfeits for one that is not ſo; nor are the right pearls a whit the leſs cordial to thoſe, that take them, becauſe the artificial pearls made at *Venice*, conſiſting of mercury and glaſs, for all their fair ſhew, are rather noxious, than medicinal. And indeed our knowledge, that there are hypocrites, ought rather to commend piety to us, than diſcredit it with us; ſince as none would take the pains to counterfeit pearls, if true ones were not of value; ſo men would not put themſelves to the conſtraint of perſonating piety, if that it ſelf were not a noble quality. Let us then, *Eugenius*, fly as far as you pleaſe from what we deteſt in hypocrites: but then let us conſider, what it is that we deteſt; which being a bare, and therefore falſe pretence to religion, let us only ſhun ſuch a pretence, which will be beſt done by becoming real poſſeſſors of the thing pretended to.

## DISCOURSE III.

### *Upon the ſight of a fair milk-maid ſinging to her cow.*

*EUGENIUS*, who was not at all indiſpoſed to liſten to exhortations of this nature, not only embraced this made him by his friend, but with earneſtneſs enough continued the conference to explain his meaning, and ſatisfy *Euſebius*, that he did not think piety fit to be diſcountenanced, though he thought hypocriſy was ſo; and that he was no enemy to the profeſſion of religion, but to thoſe, that blemiſhed it by unſuitable practices. And with ſuch kind of diſcourſes we continued our walk, till being come to a ſtyle, over which we were to paſs out of one meadow into another, I chanced to ſtop, and turn about to pay *Lindamor* the reſpect of deſiring him to lead me the way over: but not finding him there, I haſtily caſt my eyes all over the field, till at length they diſcovered him a good way off, in a poſture, that ſeemed extremely ſerious, and wherein he ſtood as immoveable as a ſtatue. This ſight ſoon carried me towards him, and I had diſpatched half my way, before his changing his poſture gave him an opportunity to diſcover me; which as ſoon as he did, he immediately came to meet me, and almoſt before I had aſked him the occaſion of what I had ſeen, Whilſt (replied he) *Eugenius* was purging himſelf from a fault, that none that knows him will ſuſpect him to be guilty of; I was detained a little behind you by the muſick of one of thoſe larks, whoſe melody was ſo charming, that I could not find in my heart to make haſte from it: but whilſt I was liſtening to it, my attention was diverted by a nobler object; for I heard from the further corner of this meadow, a voice, which, though not governed with ſkill, did ſo repair the want of it by its native ſweetneſs, that art was abſent without being miſſed, and I could not but have ſome curioſity to ſee, who was the poſſeſſor of ſo much power to pleaſe. Turning then my ſteps towards that part of the field, whence the voice came, my eyes quickly ceaſed to envy my ears; for they diſcovered, kneeling by a cow, and ſinging to her whilſt ſhe milked her, a perſon, who, in the habit of a milk-maid, ſeemed to diſguiſe one of thoſe nymphs, that poets are wont to deſcribe to us. And that you may not wonder, continues *Lindamor*, at what I ſhall ſay to you of a country girl, know, that methought I ſaw in her face ſomething more like *Hermione*, before ſhe proved inconſtant, than I expected to find in any of her ſex. I will not tell you, that this fair creature had the bluſhes of the morning in her cheeks, the ſplendor of the ſun in her eyes, the freſhneſs of the fields in her looks, the whiteneſs of the milk ſhe expreſſed in her ſkin, and the melody of the larks we were admiring in her voice, leſt you ſhould think Mr. *Boyle*'s Seraphick Love had loſt its operation on me. But I may perhaps, without much hyperbole, give you this account of her, that though her clothes are almoſt as coarſe as cleanly; and though they are ſuited to her condition, yet they are very ill ſuited to her beauty; which, as if nature intended a triumph over fortune, has, without any aſſiſtance of ornament, more diſtreſſed my liberty, than others have been able to do with all their moſt curious dreſſes. And this fair creature, continues *Lindamor*, as ſhe is rich in nature's bounty, appeared as well by the chearfulneſs of the tune ſhe ſung, as by the manner of her ſinging it, ſo ſatisfied with the unpurchaſed treaſures ſhe poſſeſſes, that ſhe ſeemed almoſt as much pleaſed as I was to look upon her. This character of *Lindamor*'s inviting me to go ſee, whether or no it were deſerved; and the frequent experience I have had, that even upon ſuch bright eyes as poets, and lovers, called ſuns, I could gaze undazzled enough to approve my ſelf a right eagle, aſſuring me I might ſafely do it, I fearleſly, but ſoftly, approached the place, where the fair milk-maid was ſolliciting the udder of a freſh cow; and I found, that though indeed ſome reſemblance ſhe had to *Hermione* had made *Lindamor* flatter her, yet ſhe looked at once ſo innocently, and prettily, that ſhe ſeemed like to do miſchief, without at all intending it; and I could not but fancy, that if ſome ladies, that are much cried up, and are very imperious miſtreſſes, becauſe they are ſo, were bound to change dreſſes with this unſophiſticated and unadorned maid, the one would appear to owe her beauty to art, and the other to be beholden for her's to nothing but nature. But *Lindamor*, who is not naturally indiſpoſed to be amorous, did not think, that this imagination of mine did that pretty creature right; for when I told him, ſhe would eclipſe a hundred of our fine ladies, if ſhe had but the dreſs of one of them, Why, that (replies he, with a kind of indignation) ſhe can do without it; and perhaps, (ſubjoins he) as much as with it. For her preſent habit leaves her moſt her ſelf; and bravery would but diſguiſe, or hide what it cannot adorn. And I am confident, ſident, (continues he) that ſhould ſuch a genuine beauty appear among the gallants, ſhe would really captivate many, even of thoſe wary ones, that do but pretend to be ſo, to the deſigning and applauded ladies; for though ſkill may encounter the wiles of art, it would ſcarce be able to reſiſt the charms of nature. But whilſt *Lindamor* was thus complimenting with what he fancied the picture of his once loved *Hermione*, and had his eyes as much fixed upon her, as dazzled ones could be, the lovely milk-maid, (who all this while having not taken notice of us, was as regardleſs of *Lindamor*, as he ſeemed to be of all things but her) having diſpatched what ſhe was doing, took up her pail to carry it homewards: but her way chancing to lie by that part of the meadow, where we were yet ſtanding, ſhe could not but diſcover us; and judging by our clothes, and more by *Lindamor*'s mein, that we were of a quality differing from theirs ſhe was wont to converſe with, ſhe gave us a ſalute low enough to let us ſee, that ſhe forgot not her condition; but attended with ſo much gracefulneſs, as made *Lindamor* conclude ſhe merited a better, and, as ſhe paſſed by him, to return the geſture of reſpect, which he thought ſo much beauty had a right in any habit to exact. She vouchſafed him a ſmile, which, I after told him, would have made him happy, if he had thought it had proceeded from kindneſs, not civility; and ſhe went away with a look ſo ſerene, as well as taking, that ſhe ſeemed to carry home with her far more quiet, than ſhe left him poſſeſſed of. But I, that had loſt ſight of her, without loſing any thing with it, ſave the expectation of ſeeing in haſte ſo fair a milk-maid, was going to railly with *Lindamor* about what had paſſed, when I was reſtrained, by perceiving, that the ſight of a perſon, that ſeemed ſo contented, together with the native pleaſantneſs of that place, and of that glorious morning, had ſuch an operation upon him, that he could not forbear to celebrate the happineſs and innocency of a country life. And after he had, with much tranſport, and fluency, repeated the ſubſtance of what *Ovid* and other ancient poets had in their ſtrain delivered, concerning the felicity of the golden age, he began to apply as much of it as the matter would bear, to the recommending of a rural life; and was very ſollicitous to make me acknowledge, that though we are wont to look upon villagers, as an inferiour and wretched ſort of people, yet they are the perſons of the world, whoſe condition is the moſt proper, not only to keep them innocent, but to make them happy; their cheap and ſimple way of living allowing them to reſt contented with what bounteous nature has provided for them, or an eaſy induſtry can procure them. Whereas among men nobly born, or perſons of quality, it is looked upon as want of breeding, for a man not to think himſelf unhappy, as long as he hath not a thouſand pounds a year.

LINDAMOR, though he here made a pauſe to take breath, would yet perhaps have proſecuted his diſcourſe, had he not been prevented by the intervening of *Euſebius*, who, a while after we had left him, having miſſed us, had followed us to the place he found us in, and who, when he drew nigh, having over-heard *Lindamor* ſpeaking, ſtood ſtill a while at ſome diſtance off, to liſten to what he ſaid, and ſo became an unſuſpected auditor of the laſt part of his friend's diſcourſe. Whereupon taking him by the hand, and leading him towards the river, he told him, with a ſerious, not to call it a ſevere look; I had thought, *Lindamor*, you had made righter eſtimates of the ſeveral courſes of life, than by what I have newly over-heard you to ſay, I now ſuſpect you do. Know then, *Lindamor*, (adds he) that innocence and contentment depend more upon a man's mind, than upon his condition. To manifeſt this to you, I ſhall in the firſt place obſerve, that it is not always the occaſion, or the object, but rather the degree, that makes an affection of the mind unruly and troubleſome: nor is it according to the intrinſick value of things, which none ſave the wiſe can diſcern: but the rate, how unſkilfully ſoever fixt, which we put upon them, that they operate upon our paſſions. And therefore, you ſhall ſee a child take on more ſadly for the ſcape of a ſparrow, or the breaking of a rattle, than ſome will do for the loſs of a good eſtate, nay, of a friend; and *Haman*, for the want of a bow from *Mordecai*, complained more in his palace, than *Job*, till his miſerable comforters had exaſperated his grief, did for the loſs of the biggeſt fortune in the Eaſt, and of the children he reſerved it for, and valued far above it.

AND then, *Lindamor*, (continues *Euſebius*) do not imagine, that though courtiers and gallants have more ſplendid and glittering temptations to ſin and diſcontent, country people are exempted from temptation to either: theirs may be as great, though not the ſame, nor ſo ſpecious as the other; their faults and infelicities are indeed leſs taken notice of, becauſe their perſons and conditions are obſcure, and their poverty conceals their vices, as well as their virtues, from our eyes; as in a ſharp winter, the ſnow does as well hide their dung-hills, as cover their gardens. But if your quality allowed you to acquaint yourſelf with the true ſtate of this inferiour ſort of people, you would ſoon perceive, that even of rural families, there is ſcarce any, that, as far as their wits will reach, has not its ſeveral parties, and little intrigues; nor is there any cottage ſo low, and narrow, as not to harbour care, and malice, and covetouſneſs, and envy, if thoſe, that dwell in it, have a mind to entertain them. And what envy alone may do to produce crimes and diſcontents, we may conjecture by what happened betwixt *Cain* and *Abel*, ſince their being heirs to the whole world could not keep two brothers at peace, whilſt one of them was envious: and there are ſome ſordid vices, which are more incident to the meaner and more neceſſitous ſort of men, as ſpiders and cobwebs are wont to abound more in thatched cabins, than in great men's houſes. I ſhould perhaps (ſays *Euſebius*) think theſe people happy, if I found they thought themſelves ſo; but the pomp and vanities of the world have oftentimes ſtronger allurements for them, than for the grandees and courtiers themſelves: for thoſe, that are poſſeſſed of theſe imaginary joys, are diſabuſed by their own experience; and thoſe, that live among theſe theatrical perſons, are near enough to diſcern, that they are but cauſeleſly envied. As, for my part, when I had occaſion to be converſant in great men's families, and the honour to preach in princes courts, the ſight of their courſe of life did as thoroughly convince me of the vanity of the world, as my ſermons endeavoured to convince them. Whereas country people ſee but the glittering and deluding outſide of greatneſs; and beholding it at a diſtance, ſee it in the favourableſt light which men can behold it in; and conſequently are ſtrongly tempted to envy what they admire, and repine at their own condition, for the want of it: nay, every gaudy trifle, that thoſe that live in towns and cities chance to make ſhew of, is wont to make a country-man envy, as well as gape; and it is odds, but that very milk-maid, whoſe condition you are pleaſed to think ſo happy, envies ſome neighbouring farmer's daughter for a piece of taudry ribbon, or a black hood. Nor are they ſo much more privileged from the aſſaults of temptation, than men of higher rank; for it is not ſo much a man's outward condition, as his inward diſpoſition and temper of mind, that makes temptations either to ſin, or to diſcontent, prevalent, or unſucceſsful. When *Joſeph* was ſold into *Egypt*, and ſollicited by a woman, that would needs be his miſtreſs upon more ſcores than one, though his condition expoſed him more to hopes and fears, than almoſt any other condition could expoſe another man; and though his youth made him very capable of reliſhing the pleaſures, that his beauty made him courted to receive, by giving them: yet this chaſte youth choſe rather to be impriſoned any where, than in a fair lady's arms, and preferred the being made a captive, before the captivating of his amorous miſtreſs. But whilſt young *Joſeph* was thus chaſte in the Egyptian *Potiphar*'s houſe, his eldeſt brother *Reuben* was inceſtuous in good *Jacob*'s, whoſe family was then the viſible church of God; and *Lot*, who was chaſte and temperate in *Sodom* itſelf, was drunk, and committed inceſt in a cave: ſo much more does the ſucceſs of temptations depend upon the temper of a man's mind, than upon the place he lives in.

I KNOW not (ſays *Eugenius*) whether the innocence of rural people be more eaſy than that of great men, but ſure it is not ſo commendable: for as a woman, that has never yielded, becauſe ſhe was never ſollicited, may be called rather innocent than virtuous; ſo their condition, that owe their not being inveigled by the vanities of the world to their ignorance of them, has more in it of good fortune than of merit. I thank you for that conſideration (ſubjoins *Euſebius*) for I confeſs I think there is a great diſparity betwixt an unacquaintedneſs with the bewitching pleaſures of the world, and a contempt of them. And he is the truly heroick ſpirit, that can (as *David* could) plentifully enjoy all thoſe ſenſual delights and vanities he choſe to reject: for he could feaſt a nation, and prefer temperance before all that abundance: he could gain ſtrange victories at once over his outward enemies, and over the temptations he was expoſed to by ſuch ſucceſſes: he could build ſtately palaces, and then profeſs himſelf to be but *a ſtranger, and a ſojourner upon earth:* he could afford humility room to ſit with him on his throne, and could liſten to her mementoes amidſt all the acclamations of his people, and the panegyricks of his courtiers: he was not to be reſiſted by beauties, that to others were irreſiſtible, when he poſtponed the faireſt objects, that could here charm his eyes, to ſuch as were viſible only to thoſe of faith: he had got together the greateſt treaſure, that for aught I remember we read of in any hiſtory, and yet ſeems never to have been much pleaſed with it, but when he dedicated it to the building of the temple, and made the fruits of his valour the oblation of his piety. To be ſhort, he was the greateſt perſon upon earth, when he was content to leave it; and was willing to deſcend from the throne into the grave, whilſt he looked upon that as the place whence he muſt aſcend to the manſion of his God: ſo much did he, even whilſt he wore an earthly crown, aſpire to an heavenly one. And though (continues *Euſebius*) we muſt now-a-days as little expect to meet with a man of *David*'s condition, as of his temper, yet proportionably we may put a vaſt difference betwixt thoſe that but eſcape the ſight of the world's allurements, and thoſe that reject the profers of them.

EUSEBIUS was in this part of his diſcourſe, when we were come near enough to the river, to diſcover it within a little way of us: and therefore finding by his ſilence, that he thought it ſeaſonable to deſiſt, I only ventured to tell him with a low voice, as we continued our walk, that I ſuſpected, that in ſome of the things he had been ſaying, he had a deſign rather to check *Lindamor* a little, and keep up the diſcourſe, than to deny, that a retired and rural life has great advantages towards contentation. To which, that he might conclude what he had to ſay, before we reached the river, he made haſte to reply in the ſame tone, that I was not altogether miſtaken; for (ſays he) I think the caſe may be pretty well repreſented, by ſaying, that as there are ſome airs very much wholeſomer than others, and fitter to preſerve men from diſeaſes; ſo a very private and quiet condition of life does, much more eaſily than a more expoſed and turbulent one, protect moſt ſorts of men from vices and diſquiets. But then, on the other ſide, as there are ſome men of ſuch ſound and ſtrong conſtitutions, that they will enjoy their health in the worſt airs, when men of tender and vitiated complexions will be ſickly in the beſt; ſo there are ſome generous and ſteady ſouls, that will paſs thorough the moſt troubleſome and moſt expoſed courſes of life, with more of both innocence and contentment, than others can enjoy in a condition far remoter from diſturbances and temptations. And, annexes *Euſebius*, (purpoſely raiſing his voice) as for theſe villagers, that *Lindamor* thought ſo happy, I muſt diſſent from him, as long as I ſee they can admire, and almoſt worſhip, a man for wearing a gaudy ſuit of clothes, or having two or three footmen behind his coach, before they know whether he be not a knave, or a fool, or both: for I ſhall ſcarce think, that he, who is himſelf poſſeſſed with envy, deſerves mine.

## DISCOURSE IV.

### *Upon fiſhing with a counterfeit fly.*

BEING at length come to the river-ſide, we quickly began to fall to the ſport, for which we came thither; and *Eugenius* finding the fiſh forward enough to bite, thought fit to ſpare his flies, till he might have more need of them, and therefore tied to his line a hook, furniſhed with one of thoſe counterfeit flies, which in ſome neighbouring countries are much uſed, and which being made of the feathers of wild-fowl, are not ſubject to be drenched by the water, whereon thoſe birds are wont to ſwim. This fly being for a pretty while ſcarce any oftener thrown in, than the hook it hid was drawn up again with a fiſh faſtened to it, *Eugenius* looking on us with a ſmiling countenance, ſeemed to be very proud of his ſucceſs: which *Euſebius* taking notice of, Whilſt, (ſays he) we ſmile to ſee, how eaſily you beguile theſe ſilly fiſhes, that you catch ſo faſt with this falſe bait, poſſibly we are not much leſs unwary ourſelves; and the world's treacherous pleaſures do little leſs delude both me and you: for, *Eugenius*, (continues he) as the Apoſtles were fiſhers of men in a good ſenſe, ſo their and our grand adverſary is a ſkilful fiſher of men in a bad ſenſe; and too often in his attempts, to cheat fond mortals, meets with a ſucceſs as great and eaſy, as you now find your's. And certainly, that tempter, as the Scripture calls him, does ſadly delude us, even when we riſe at his beſt baits, and, as it were, his true flies: for, alas! the beſt things he can give, are very worthleſs, moſt of them in their own nature, and all of them in compariſon of what they muſt coſt us to enjoy them. But, however, riches, power, and the delights of the ſenſes are real goods in their kind, though they be not of the beſt kind; yet, alas, many of us are ſo fitted for deceits, that we do not put this ſubtile angler, to make uſe of his true baits to catch us! We ſuffer him to abuſe us much more groſsly, and to cheat us with empty titles of honour, or the enſnaring ſmiles of great ones, or diſquieting drudgeries diſguiſed with the ſpecious names of great employments. And though theſe, when they muſt be obtained by ſin, or are propoſed as the recompences for it, be, as I was going to ſay, but the devil's counterfeit flies: yet, as if we were fond of being deceived, we greedily ſwallow the hook, for flies, that do but look like ſuch; ſo dim-ſighted are we, as well to what vice ſhews, as to what it hides. Let us not then (concludes *Euſebius*) riſe at baits, whereby we may be ſure to be either groſly, or at leaſt exceedingly deceived; for, whoever ventures to commit a ſin, to taſte the luſcious ſweets, that the fruition of it ſeems to promiſe, certainly is ſo far deceived, as to ſwallow a true hook for a bait, which either proves but a counterfeit fly, or hides that under its alluring ſhew, which makes it not need to be a counterfeit one to deceive him.

## DISCOURSE V.

### *Upon a fiſh's ſtruggling after having ſwallowed the hook.*

FORTUNE ſoon offered *Euſebius* a fair opportunity to confirm this laſt part of his reflection; for he had ſcarce made an end of it, when a large fiſh, eſpying the fly, that kept my hook ſwimming, roſe ſwiftly at it, and having greedily chopt it up, was haſtily ſwimming away with it, when I ſtruck him, and thereby ſtopt for a while his progreſs: but finding himſelf both arreſted and wounded, he ſtruggled with ſo much violence, that at length he broke my ſlender line, (that was fitted but for weaker fiſhes) and carried away a part of it, together with the annexed hook and bait. If philoſophers (ſays hereupon *Euſebius)* be not too liberal in allowing brutes to think, we may well ſuppoſe, that this fiſh expected a great deal of pleaſure from the bait he fell upon ſo greedily; and that when once he had got it into his mouth, he might well look upon it as his own; and thoſe other fiſhes, that ſaw him ſwallow it, and ſwim away with it, did problably envy his good fortune. But yet indeed he does not enjoy his wiſh, though he ſeem to have the thing wiſhed for within his power: for by the ſame action, in which he ſucked in the fly, he likewiſe took in the hook, which does ſo wound and tear his tender gills, and thereby put him into ſuch reſtleſs pain, that no doubt he wiſhes, that the hook, bait, and all, were out of his torn jaws again, the one putting him to too much torture to let him at all reliſh the other. Thus men, who do what they ſhould not, to obtain any object of their ſenſual deſires, whatever pleaſure they may beforehand fancy to themſelves in their ſucceſs, are oftentimes, even when they obtain their ends, diſappointed of their expectations; ſometimes conſcience, reaſon, or honour, making them, even when their deſires are not of the worſt ſort, do as *David* did, when he had, more vehemently than became a pious general, longed for water out of the well at *Bethlehem*; and by the ſtrange venturouſneſs of his bold and affectionate officers obtained it, could not find in his heart to drink it, but poured it untaſted on the ground. But when the things we ſo long for muſt be criminally obtained, then it not only often fares with them, as it did with *Amnon*, who immediately upon the inceſtuous fruition of his raviſhed ſiſter, hated her more than before he had loved her: but it ſometimes happens to thoſe, that ſin more heinouſly in this matter, as it did to *Judas*, who, after having betrayed a maſter, that was incomparably more worth than all the world, and thereby for ever loſt himſelf for a few pieces of ſilver, ſeemed to have it in his power, without having it in his will, to enjoy them, and in a deſperate but unſeaſonable fit of anguiſh and remorſe, did of his own accord diſburthen himſelf of that money, which he had ſold his conſcience to get; ſo that though he had what he ſought, he had not what he expected. And when what he coveted was in his poſſeſſion, he had the guilt of acquiring it, without the power of enjoying it. And even in caſes far leſs heinous, (concludes *Euſebius)* when men ſeem to have got what they aimed at, and to have carried it away as their booty, in ſpite of all oppoſition, the wound thereby inflicted on injured conſcience puts them to ſo much of deſerved pain, that the wiſhes they are thus criminally poſſeſt of, they do not enjoy, but deteſt.

## DISCOURSE VI.

### *Upon the ſight of one's ſhadow caſt upon the face of a river.*

THE ſight of ſome fiſhes playing to and fro upon the top of the water diverted us from proſecuting our conference, and drew us to apply our ſelves attentively to the catching of them, in which accordingly we ſpent ſome part of the morning; yet whilſt we continued angling, not far from one another, we often caſt our eyes (as is uſual in ſuch caſes) upon each other's fiſhing corks, to learn as well the ſucceſs of our friends, as in what places the fiſh were forwardeſt to bite. As I chanced to look towards that cork, at which *Euſebius*'s hook was hanging, I perceived, that it was divers times drawn under water, without his endeavouring thereupon to ſtrike that fiſh, that made thus bold with his bait: wherefore laying down my angle a while, I went ſoftly towards *Euſebius*, to ſee what it was, that made him ſo regardleſs of his ſport, whilſt yet, by the poſture he continued in, he ſeemed to be intent upon it; but approaching near enough, I quickly perceived, that inſtead of minding his hook, his eyes were fixt ſometimes upon his own picture, reflected from the ſmooth ſurface of the gliding ſtream, and ſometimes upon the ſhadow projected by his body, a little beſide the picture upon the ſame river.

The unwilling noiſe I made in coming ſo near having obliged *Euſebius* to take notice of me, I thought fit, ſince I found I was diſcovered, to aſk him ſmilingly, whether he were, *Narciſſus*-like, making love to his own ſhadow.

Eusebius gueſſing by theſe words, that I had conjectured what he was doing, anſwered me with a look ſomewhat more ſerious than that I had ſpoken to him with; I was indeed, *Philaretus*, attentively enough conſidering, ſometimes my picture, which the water preſents me with, and ſometimes the ſhadow, which the ſun and I together caſt upon the water: but (ſays he, with a half ſmile) I looked upon both theſe, not with the eyes of a *Narciſſus*, (for that would make me much madder than he was) but with thoſe of a Chriſtian. For I was conſidering, that one of the differences betwixt the law and the goſpel, might not be ill repreſented by the difference betwixt a common looking-glaſs, and that afforded me by this cryſtal ſtream: for though, both being ſpecular bodies, I can ſee my face in either; yet if my face be ſpotted with dirt, or grown pale by reaſon of the faintneſs uſual in ſuch hot weather, a common looking-glaſs will indeed diſcover thoſe things to me, but will not otherwiſe aſſiſt me to remedy them; whereas, when I conſult this ſtream, if it ſhew me any ſpots in my face, it ſupplies me with water to waſh them off, and by its cooling and refreſhing waters, can relieve me from that faintneſs, that reduces me to look pale.

Thus the law, which is commonly, and which ſeems even by an Apoſtle to be compared to a looking-glaſs, ſhews us indeed the pollutions of our ſouls, and diſcovers to us the effects of our ſpiritual languidneſs, and faintneſs; but the goſpel does not only do ſo, but tells the embracers of it, by Saint *John*'s mouth, *If any man ſin, we have an advocate with the Father, Jeſus Chriſt the righteous, who is the propitiation for our ſins, and whoſe blood cleanſes us from all ſin.* And the author of the ſame goſpel invites all thoſe, that find themſelves tired and thirſty, to come unto him, and to be refreſhed.

By this time *Lindamor*, who was angling not very far off, perceiving us ſtand together, as if we were engaged in ſome diſcourſe, laid by his rod a while, and came to liſten to what he expected he might learn from *Euſebius*; who pauſing here, I put him in mind, that he had alſo mentioned to me the ſight of his ſhadow upon the face of the river, as another object of his contemplations, and that therefore my curioſity (wherein I knew *Lindamor*, as ſoon as I ſhould acquaint him with the occaſion, would ſhare) made me very deſirous to know what thoughts had been ſuggeſted to him by a ſubject, that ſeemed ſo ſlight and barren.

SINCE you will needs know, (replies *Euſebius)* I will confeſs to you, that my thoughts were theologically enough employed, and therefore, leſt you ſhould think, I affect to preach out of the pulpit, I will but ſuccinctly mention ſome of thoſe various things, that this ſhadow, as deſpicable as you think it, ſuggeſted to me: but ſince I was only entertaining and exciting my ſelf, not diſcourſing with Naturaliſts, or diſputing with Atheiſts, I preſume you will not wonder, that I take the doctrine of the creation for granted, as it is acknowledged by Chriſtians in general, and particularly by you.

I WAS then conſidering, that this ſhadow, related to me, might in ſome particulars be no unfit one of the univerſe in reference to God: and indeed, perhaps the world may without much extravagance be termed the ſhadow of him, of whoſe attributes, or perfections, it exhibits to an attentive conſiderer divers excellent impreſſes, and the reſemblance may thus far be advanced: that as though it repreſents the ſhape and out-lines of my body, which projects it, yet it repreſents but them, and conſequently this ſhadow in reference to it is but a ſuperficial and worthleſs thing; ſo the world, though it be not deſtitute of ſeveral impreſſes, and as it were lineaments or features of the divine wiſdom and power, yet, for all this, its repreſentations of the divine Author of it are but very imperfect, ſuperficial, and dark, and the excellency of the adorable author of things keeps him infinitely above all the works, that he has made.

BUT to mention ſome of the compariſons I took notice of: In the firſt place we may conſider, that I make this ſhadow here without taking the leaſt pains to do ſo, and with as little toil God made the world: *He ſpake and it was done*; *he commanded and it ſtood faſt*, (ſays the Pſalmiſt, ſpeaking of the creation.) And elſewhere the ſcripture ſays, *That the everlaſting God, the Lord, the Creator of the ends of the earth fainteth not, neither is weary*; and therefore that reſt aſcribed him on the ſeventh day is to be underſtood but a ceſſation from creating, not a repoſe from labour: for all diſproportions to the power of created agents are ſo equally inconſiderable, in reference to one that is infinite, that omnipotence may make even the world without toil.

Pſ. xxxiii. 9.

Iſaiah xl. 28.

SECONDLY, To make this ſhadow, I neither uſe nor need colours, nor pencil; I dig no quarries, nor fell no trees to perfect this work, and employ no materials about it: as little had God any pre-exiſtent matter to contrive into this vaſt fabrick: our creed proclaims him the Creator of heaven and earth; the angel, that holds the book, in the *Revelations*, deſcribes him reſemblingly; and the Apoſtle tells us, *That through faith we underſtand, that the worlds were framed by the word of God*; *ſo that things, which are ſeen, were not made of things, that do appear.* And indeed it became an omnipotent architect, not to be beholden but to himſelf for his materials. He that calleth things, that are not, as though they were, makes them by calling them; *He brought forth light out of darkneſs, by calling for light, and there was light*; *and he ſpake it, and it was done*, ſays the Pſalmiſt: and the world was, if I may ſo expreſs it, but the real echo of that productive *FIAT*.

Revel. x. 6.

Hebr. xi. 3.

THE next thing, I was conſidering, was, that, to deſtroy this ſhadow, I needed neither ſword, nor piſtol, the withdrawing of my ſelf under the neighbouring trees being ſufficient to make the ſhadow diſappear, and leave behind as little ſhape of it, as if there never had been any. And thus, as the world could not have had a beginning, without having been provided by God, ſo for the continuance of the being it enjoys, it depends altogether, and every moment, upon the will and pleaſure of its firſt author, of whom St. *Paul* tells us, *That in him we not only live, and move, but have our being*; and to the ſame purpoſe I think one may alledge that place, where the ſcripture ſays of God, not only, *that he has made heaven, the heaven of heavens with all their hoſt, the earth and all things that are thereon, the ſeas and all that is therein*; but adds, *that he preſerveth them all*, as our tranſlators Engliſh it: for in the Hebrew I remember it is, *vivifies them all*, that is, ſuſtains them in that improper kind of life, or that exiſtence, which, whilſt their nature laſts, belongs unto it. So that if God ſhould at any time withdraw his preſerving influence, the world would preſently relapſe, or vaniſh into its firſt nothing, as there are many notions of the mind ſuch, as that of genus, and ſpecies, which are ſo the creatures of reaſon, that they have no longer an exiſtence in the nature of things, than they are actually upheld therein, by being actually thought upon by ſome intellectual being; and God is ſo the preſerver of all his creatures, that one may ſay of the reſt, as the Pſalmiſt ſpeaks of many of them, where addreſſing himſelf to God, he ſays, *Thou hideſt thy face, they are troubled: thou takeſt away their breath, they die, and return to their duſt*; *thou ſendeſt forth thy ſpirit, they are created*, &c.

Nehemiah ix. 6.

Pſal. civ. 29, 30.

I WAS alſo taking notice, (purſues *Euſebius*) that to produce what changes I pleaſed, in all, or any part of this ſhadow, I needed not employ either emiſſaries, or inſtruments, nor ſo much as rouſe up my ſelf to any difficult exertion of my own ſtrength, ſince by only moving this or that part of my own body, I could change at pleaſure, in the twinkling of an eye, the figure and poſture of what part of the ſhadow I thought fit: and thus, when God had a mind to work thoſe miracles, we moſt admire, as when at *Joſhua*'s prayer he ſtopped the courſe of the ſun, and at *Hezekiah*'s, made him go back; we men are apt to imagine, that theſe prodigious effects muſt needs coſt their author much, and that he muſt ſtrain his power, and be neceſſitated to a troubleſome exertion of his omnipotence, to be able to produce them: whereas to that divine agent, thoſe things, that would be to all others impoſſible, are ſo far from being difficult, and the creatures have ſo abſolute and continual a dependance on him, that it is as eaſy for him to effect the greateſt alterations in them, as to reſolve to do ſo. And even thoſe miraculous changes of the courſe of nature, that do the moſt aſtoniſh us, do ſo naturally and neceſſarily flow from the motions of his own will, that to decree, and to execute, (whether or no they require powers otherwiſe than notionally differing) are alike eaſy to him: and that irreſiſtable agent finds as little more difficulty to produce the greateſt changes among the creatures, than to produce the leaſt, as I find it harder to move the whole arm of my ſhadow, than to move its little finger. And this conſideration (ſubjoins *Euſebius*) might be, methought, conſolatory enough to his church, who, by repoſing an entire truſt in her God, entitles her ſelf to the protection of him, that can as eaſily produce changes in the world, as reſolve on them, and can with the ſame facility deſtroy her and his greateſt enemies, as decree their deſtruction.

I WAS alſo further conſidering, (ſays *Euſebius*) that though the little watry bodies, that make up this river, and conſequently thoſe, that glided along by me, were in a reſtleſs motion, the hindmoſt always urging on, and chaſing thoſe that were before them; yet my ſhadow was as compleat and ſtable upon the fugitive ſtream, as if it had been projected on the water of a pond, or rather as if all the parts of water, whereon it was viſible, had been fixt and moveleſs; of which I made this application, that though we may ſay with *Solomon*, in a larger ſenſe than his, *That one generation goes, and another comes*, the world being maintained by perpetual viciſſitudes of generation and corruption, yet the wiſdom and providence of God does ſo far confine the creatures to the eſtabliſhed laws of nature, that though vaſt multitudes of individuals are always giving place to others, yet the particular creatures, which do at any time make up the world, do always exhibit the like picture of its divine original.

But yet laſtly, (ſays *Euſebius)* I was conſidering too, that though this ſhadow have ſome kind of reſemblance to that, whoſe ſhadow it is, yet the picture is but very ſuperficial and obſcure; and if we ſhould ſuppoſe, the fiſhes, that inhabit this ſtream, to be endued with reaſon, they could even from *Lindamor*'s ſhadow but collect, that the original is a man, and not a brute; but they could not hence make any diſcovery of what manner of man he is, nor know any thing of his virtues, or his thoughts, or his intention, nor conſequently have that notion of him, that I (purſues *Euſebius*, turning to him, and a little ſmiling on him) do harbour and cheriſh, who having the happineſs to converſe with him, have the opportunity and the juſtice to admire him. Thus, where I formerly ventured to call the world God's ſhadow, I did not forget, how imperfect a picture a ſhadow is wont to be: and though this dark repreſentation, that God has vouchſafed men of himſelf in the univerſe, be ſufficient to convince us, that it was not made by chance, but produced by a powerful and intelligent being; the eternal power and God-head of the great author of nature, as the ſcripture ſeems to teach us, being manifeſted to attentive and rational conſiderers, in the viſible productions of his power and wiſdom; yet how ſhort and dim a knowledge muſt they have of him, that have no other than theſe corporal inſtructors? How many of his glorious attributes are there, for whoſe knowledge we muſt be beholden, rather to his written, than his created word? and how little will human intellects, without revelation, diſcover of that manifold wiſdom of God, which the ſcripture teaches us, *That even to the angels it muſt be made known by the church.* Epheſ. iii. 10. And if thoſe illuminated perſons, ſuch as *Moſes* and St. *Paul* himſelf, who had both extraordinary revelations from God, and intimate communion with him, confeſſed, that in this life they ſaw him but darkly, and, as it were, in a glaſs; ſure the dim light of mere nature will give us but extremely imperfect, and detracting ideas of him, whom the like limitedneſs of our nature will allow us to know but very imperfectly, in heaven it ſelf; though, as we ſhall there ſee him face to face, our apprehenſive faculties will as well be enlarged, as the dazzling and raviſhing object be diſcloſed.

But, (ſays *Euſebius)* though I forget, that I am not in the pulpit, I hope you remember, that I told you at firſt, how little I pretended theſe kind of reflections would endure a rigorous philoſophical examen; and that I am not ſo indiſcreet, as to expect, that they ſhould work conviction in an infidel, though I hope they may excite good thoughts in a believer.

These laſt words of our friend being not followed by any other; *Lindamor*, having waited a while to aſcertain himſelf, that *Euſebius* had ended his diſcourſe, began another, by ſaying:

I perceive, *Euſebius*, with much more ſatisfaction than ſurprize, that the ſame ſubject, and at the ſame time, did, as it was fit, ſuggeſt very differing conſiderations to you and me; for whilſt your ſhadow afforded you the riſe of ſublime ſpeculations, I was making but a moral reflection upon mine: for taking notice, (continues he) that the ſhade my body projected, near noon, was almoſt as much ſhorter than it, as in the morning it was longer, prompted me to think, how fooliſh it were for me, who know by ſure ways of meaſuring my own ſtature, that it is moderate enough, not to be either proud of, or complained of, ſhould imagine, that I am either as tall as a giant, or as low as a dwarf, becauſe I ſee my ſhadow either exceeding long, or extremely ſhort. And I was further conſidering, purſues *Lindamor*, that if philoſophers, as well as the vulgar, have rightly called fame or glory the ſhadow of virtue, it would be as irrational to eſtimate one's ſelf not by the teſtimonies of one's conſcience, which is the authentick ſtandard of intrinſick worth, but by the fickle opinions of others, (which oftentimes flatter, and oftener detract) but very ſeldom give a juſt and impartial eſtimate of merit: the fame may have its increaſe and decrements, whilſt the perſon continues the ſame, and loſes nothing of ſubſtance with the ſhadow. And for a man, that ſhould examine himſelf, and judge of himſelf by his own deſigns, and actions, not other men's words, to ſuffer himſelf to be puffed up by vulgar applauſe, or dejected by unmerited cenſures, were to miſtake a ſhadow for a ſtandard.

## DISCOURSE VII.

### *Upon a fall occaſioned by coming too near the river's brink.*

IT was not long after this, that *Eugenius* chancing to ſpy a little nook, which ſeemed to promiſe him a more convenient ſtation for his angling, he invited *Lindamor* to ſhare the advantage with him, and began to walk thitherward along the river's brink, which the abundant moiſture of the waters, that glided by it, had adorned with a pleaſant verdure; but he had not marched very far, when chancing to tread on a place, where the courſe of the water had worn off the bank, and made it hollow underneath, he found the earth falter under him, and could not hinder his feet from ſlipping down with the turf that betrayed him; nor could he have eſcaped ſo, had not his endeavours to caſt the weight of his body towards the bank been aſſiſted by *Lindamor*, who, though not ſo near the brink as to be in danger, was not ſo far off, but that he was able to catch hold of him, and to draw him to the firm land. The noiſe, that *Lindamor* made, when he ſaw his friend falling, quickly drew *Euſebius* and me thither; where, after I had a while made my ſelf merry with the diſaſter, I found to have been ſo harmleſs; *Euſebius* (who arrived there a little later) aſked him how he came to fall; and *Eugenius* anſwering, that he thought he had trod upon firm ground, becauſe he ſaw the bank look to the very edge, as if it differed not from the reſt of the field, which it terminated: *Euſebius* took occaſion from thence to tell him, You may from this take notice, that it is not ſafe travelling upon the confines of what is lawful, and what is ſinful, no more than upon the borders of two hoſtile nations: when we ſuppoſe, that thus far we may go towards that which is ſinful, without committing it, we are wont with more boldneſs than conſiderateneſs to conclude, that we need not ſcruple to venture, or rather that we ſhall run no venture, having firm footing all the way. But it is much to be feared, that when we allow our ſelves to come as far as the utmoſt verge of what is lawful, and to do that, which, in the caſuiſt's language, is *tantum non* to ſin, the natural proclivity of our minds to evil, which carries them downwards, as weight does our bodies, will ſome time or other make us find hollow ground, where we preſume to find it firm. He that to-day will go towards ſin as far as he thinks he may, is in danger of going to-morrow further than he ſhould; and it is far more eaſy for him to be ſecure than to be ſafe, that walks upon the brink of a precipice. He was a wiſe man, that as ſoon as he had forbidden his ſon to enter into the path of the wicked, and to go in the way of evil men, ſubjoins, as the beſt courſe to conform to the preſcription, Avoid it, paſs not by it, turn from it, and paſs away. God's indulgence leaves us a

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latitude to comply with our infirmities, and neceſſities, and to give us opportunities of exerciſing a pious jealouſy over our ſelves, and of ſhewing how much we fear to offend him. But a wary Chriſtian will ſay in this caſe, as St. *Paul* did in almoſt a like, *all things are lawful for me, but all things are not expedient:* and he muſt often go further than he can with prudence, that will always go as far as he thinks he can with innocence.

## DISCOURSE VIII.

### *Upon the good and miſchief that rivers do.*

THIS diſcourſe being ended, we all, as it were, by common conſent, applied ourſelves again to proſecute the ſport that had invited us to the river: but we had not angled very long, before we were diſturbed by a confuſed noiſe, which we ſoon diſcovered to proceed from a ſhip, that, together with ſome barges, and other leſſer boats, were, by the help of a favourable breath of wind, ſailing up the river towards *London*. The ſight of theſe laden veſſels, together with the proſpect of the *Thames*, which, (as it happened in that place) ſeemed, in various windings and meanders, wantonly to fly, and to purſue it ſelf: this ſight, I ſay, together with the rich and flouriſhing verdure, which the waters, in their paſſage, beſtowed upon all the lands, that were on either ſide any thing near their banks, invited *Eugenius* to fall upon the praiſes of that excellent river, which not only imparts fertility and plenty here at home, by inriching all the places that have the advantage to be near it; but helps to bring us home, whatever the remoter parts of the world, and the Indies themſelves, whether eaſt or weſt, have of rare or uſeful.

Lindamor, having both applauded and recruited theſe commendations, Methinks, ſays he, that amongſt other good things, wherewith this river furniſh us, it may ſupply us with a good argument againſt thoſe modern Stoicks, who are wont, with more eloquence than reaſon, to declaim againſt the paſſions, and would fain perſuade others, (for I doubt whether they be ſo perſuaded themſelves) that the mind ought to deal with its affections, as *Pharoah* would have dealt with the Jews-males, whom he thought it wiſe to deſtroy leſt they might, one day, grow up into a condition to revolt from him. But becauſe the paſſions are (ſometimes) mutinous, to wiſh an apathy is as unkind to us, as it would be to our country, to wiſh we had no rivers, becauſe (ſometimes) they do miſchief, when great or ſudden rain ſwells them above their banks.

When I conſider, (ſays *Euſebius*) that of the immaculate and divine lamb himſelf, it is recorded in the goſpel, that *he looked round about, upon certain Jews, with indignation, being grieved for the hardneſs of their hearts*; ſo that two paſſions are aſcribed to Chriſt himſelf in one verſe: and when I conſider too the indifferency (and conſequently the innocence) of paſſions in their own nature, and the uſe, that wiſe and virtuous perſons may make of them, I cannot think we ought to throw away (or ſo much as wiſh away) thoſe inſtruments of piety, which God and nature has put into our hands; but am very well content we ſhould retain them, upon ſuch conditions, as *Abraham* did thoſe domeſticks he bought with his money, whom, the Scripture tells us, *he both circumciſed and kept as ſervants.*

But, (continues *Euſebius*) as I do not altogether diſallow *Lindamor*'s compariſon between rivers and paſſions, ſo he muſt give me leave to add this to it, that as rivers, when they over-flow, drown thoſe grounds, and ruin thoſe huſbandmen, which whilſt they flowed calmly betwixt their banks, they fertilized and enriched; ſo our paſſions (when they grow exorbitant and unruly) deſtroy thoſe virtues, to which they may be very ſerviceable whilſt they keep within their bounds.

INSTANCES of this truth, (purſues *Euſebius*) are but too obvious. It is ſaid, that valour is anger's whetſtone; and our being counſelled by the apoſtle, *to be angry and not to ſin*, argues that paſſion not to be incompatible with innocence, whilſt it is confined within the limits of moderation. But when once anger is boiled up into rage, or choler into an habitual fury, or appetite of revenge, it makes more havock in the world than beaſts and inundation: the greateſt part of thoſe rivers of blood, that are ſhed in battles, (though ſpilt by anger) do rather irritate than appeaſe the unnatural thirſt of that inſatiate fury: the burning of cities, the ſinking of fleets, and the deſolations of provinces, and of kingdoms, make but part of the tragick effects of this inhuman paſſion, when it once thoroughly poſſeſſes thoſe, that wield ſcepters, and handle ſwords.

I WILL not tell *Lindamor*, that even that nobleſt and beſt of paſſions, love, as gentle and amiable as it appears, when once it comes to degenerate by growing unruly, or being miſplaced, is guilty of far more tragedies than thoſe, that have the fortune to be acted on theatres, or to furniſh the writers of romances; and that which (perchance at firſt) ſeems to be but an innocent love, being not duly watched, and regulated, may, in time, grow to diſobey, or deceive parents, to violate friendſhips, to ſend challenges, and fight duels, to betray the honour of harmleſs virgins, and of the nobleſt families, to rebel againſt kings, procure the ruin of monarchies and commonwealths; and, in a word, to make thouſands miſerable, and thoſe it poſſeſſes moſt of all, and thereby to bring credit to, if not alſo to ſurpaſs, the fictions of poets, and the fabulous ſtories of romances.

AND as for the deſire of excelling others, as great and noble things as it makes men undertake, whilſt it aſpires only to a tranſcendency in virtue, and in goodneſs, when that paſſionate deſire, by making men too greedy of ſuperiority in fame and power, degenerates into ambition; how many vices are uſually ſet at work by this one paſſion! The contempt of the laws, the violation of oaths, the renouncing of allegiance, the breach of leagues and compacts, the murder of one's neareſt relations, (if they be more nearly related to a crown) and all the other crimes and miſeries, that are wont to beget or attend civil wars, are the uſual as well as diſmal productions of this aſpiring humour in a ſubject. Nor does it leſs miſchief when harboured in a prince's breaſt; for the undoing of his own people, the ſubverſion of his neighbour's ſtates, the ſacking of cities, the ſlaughter of armies, the diſpeopling of ſome provinces, and the peopling of others with widows and orphans, are ſacrifices, that are more frequently offered up to ambition, than able to ſatisfy it. For what can quench his thirſt of rule and fame, or hinder the attempts, to which it ſtimulates him, that can find in his heart to deſtroy armies, and ruin provinces, only that he may be taken notice of to be able to do ſo?

CERTAINLY (ſubjoins *Euſebius*) he knew very well the frame of human ſpirits, that ſaid by the pen of an Apoſtle; *From whence comes wars and brawlings among you?* James iv. 1. *Come they not hence, even of your luſts that war in your members.* And I doubt not, whether plagues, wars, and famines have done more miſchief to mankind, than anger and ambition, and ſome other inordinate paſſions; for theſe do frequently bring upon men thoſe publick and other fatal calamities, either as judgments, which they provoke God to inflict, or as evils, which as proper conſequents naturally flow from thoſe miſchievous practices, to which unbridled paſſions hurry the criminally unhappy perſons they have enſlaved.

WHEREFORE, (concludes *Euſebius*, caſting his eyes upon *Lindamor*) as the uſefulneſs of a river hinders us not from making good the banks, and, if need be, making dams, to confine it within its limits, and prevent its inundations; ſo the uſefulneſs of the paſſions ſhould not hinder us from watchfully employing the methods and expedients afforded us by reaſon and religion, to keep them within their due bounds, which they ſeldom overflow without ſhewing, to our coſt, that, as it is obſerved of fire and water, they cannot be ſo good ſervants, but that they are worſe maſters.

## DISCOURSE IX.

### *Upon the comparing of lands, ſeated at different diſtances from the river.*

THIS laſt diſcourſe, to which the river had afforded the occaſion, inviting me to ſurvey as much of it, as was within my view, a little more attentively, gave me the opportunity of taking notice of a manifeſt difference betwixt the lands that lay near it, and thoſe whoſe ſituation was remoter from it; and having acquainted *Euſebius* with what I had obſerved, which his own eyes could not but preſently bear witneſs to; One (ſays he) that ſhould only conſider how ſwiftly this ſtream runs along theſe flowery meadows, and how great a quantity of water paſſes through them, and from them, towards the ſea, would be apt to conclude, that certainly theſe grounds retain none of the water, which runs from them ſo haſtily, and ſo plentifully; eſpecially ſince we can ſee no channels, nor other manifeſt inlets, and receptacles, that ſhould divert and retain the fugitive water, ſo that the grounds confining on the river muſt be but little advantaged by its neighbourhood. But, (continues *Euſebius*) though theſe grounds have not any patent paſſages, whereby to derive water and fatneſs from the river, and therefore muſt ſuffer the greateſt part of it to run by them undiverted; yet ſtill ſome of the cheriſhing and fertilizing moiſture is from time to time ſoaked in by the neighbouring ground, and (perhaps by blind pores and crooked channels) ſo diſperſed thorough the whole fields, that they have thereby water, and in that vehicle fertility conveyed to them; which you will not doubt, if you do but with me take notice, how much the lands, that lie on both ſides near the courſe of the river, are more verdant, and flouriſhing, and more rich, than thoſe leſs happy grounds, to whom their remoteneſs denies the advantages of ſo improving a neighbourhood.

THUS (reſumes *Euſebius*) many a pious perſon, that is an aſſiduous attendant on the means of grace, and has a care to place himſelf, as it were, in the way, by which the ordinances of God, eſpecially thoſe of reading and expounding of the Scriptures, are wont freely and copiouſly to flow, is (eſpecially upon any fit of melancholy, or diſtreſs of mind) apt to be extremely diſcouraged from proſecuting that courſe of duties; and by looking upon the little, that he remembers of ſo many excellent ſermons as he has heard, he is often inclined to conclude, not only he has loſt all the good ſermons, that he has heard already, but that at leaſt for ſuch as he, there is little to be expected from them for the future.

BUT though to loſe ſo much of a thing, ſo precious as the doctrine of ſalvation, be that, which is oftentimes a fault, and always an unhappineſs; yet it is a far leſs miſchief to forget ſermons than to forſake them; the one may be but an effect of weak memory, the other is that of a depraved will, perverted by lazineſs, impatience, or ſome greater fault. We ſhould ſcarce allow it for a rational proceeding, if one in a conſumption, or diſentery, becauſe he grows not fat with feeding, ſhould reſolve to renounce eating and drinking.

BUT this (ſays *Euſebius*) is not that, which I chiefly intended: for pious, but melancholy perſons, are oftentimes too partial againſt themſelves, to be competent judges of their own eſtate; they ſeem not to forget any ſermon ſo much, as that charity ſhould begin at home; and they are much more careful not to accuſe any body wrongfully than themſelves: though they might remember, that in the eſtimate of Chriſt himſelf, all grounds are not equally fruitful, that are good; ſome bringing forth hundred, ſome ſixty, ſome but thirty fold, and yet to all he vouchſafes the title of good. And though, as mad men, that have quite loſt their wits, ſeldom or never complain of the want of them; ſo thoſe, that have forfeited, or are devoid of grace, rarely bemoan themſelves of the weakneſs of it. And it is no mean ſign of proficiency in piety, to be apt to deplore one's unproficiency in piety. It is true, that preaching is not always, and I fear not ſo much as often, the ſavour *of life unto life*; the perverſeneſs of the hearers making it but too frequently the ſavour *of death unto death*. But yet, ſpeaking in the general, though it aggravate the ſins committed in ſpite of it, yet it uſually hinders many others from being committed; and he, that twice a week is told of God, and duty, and heaven, and hell, has his conſcience more awaked, than he, that never hears of any of theſe things. And if you but compare one of theſe deſpondent Chriſtians, we are conſidering, with the careleſs ſenſualiſts, that fly a rouzing ſermon, as they ſhould do what it would deter them from; you will eaſily diſcern a ſufficient diſparity between them, to invite you to conclude, that the inſtructiveneſs of preaching may, like the moiſture of the river, be conveyed but by little and little at a time, and by unperceived paſſages, and yet be able to impart fertility. For though much run by, yet commonly ſomething will ſtick; which we may ſafely conclude, if though we can diſcern it no other way, it diſcloſe it ſelf by the effects. For it is not always to thoſe, that remember the moſt of them, that ſermons do the moſt good, as water retained in ponds makes not the bottom flouriſhing, but the banks; and the efficacy of a ſermon is better to be collected from the impreſſion it has on the underſtanding and affections, than from that it leaves on the memory: whether we retain the particulars faithfully or no, and carry them home with us; yet if a ſermon leave us devouter than it found us, if we go from God's ordinances, with a love to them, and a reliſh of them, and a purpoſe to frequent them, we may be deſpondents, but are not altogether non-proficients: that incorruptible ſeed, by which we are regenerated, being once thrown into an honeſt heart, may, as our Saviour intimates, grow up we know not well how, and though perhaps by inſenſible degrees, yet at length attain maturity. To diſpatch, (concludes *Euſebius*) whether or no a man can orderly repeat all the particulars that compoſed the ſermon, it does him good, if it either makes him good, or keeps him ſo; and its operation is to be eſtimated, not ſo much by what we remember, as by what we reſolve.

WHAT you have been ſaying, (ſubjoins *Lindamor*, when he perceived that *Euſebius* had done ſpeaking) ſuggeſts to me a reflection, that till now I did not dream of; and though it differ from that, wherewith you have been pleaſed to entertain us, yet becauſe it is applicable to the ſame purpoſe, and occaſioned by the ſame river, I ſhall without ſcruple, though, after your diſcourſe, not without bluſhes, tell you, that it is this; I, among many others, that live near it, have often reſorted in hot weather to this river, to bathe my ſelf in it; and after what I have been hearing, I now begin to conſider, that though incomparably the greater part of the river run by me, without doing me any good, and though when I went out of it, I carried away little or none of it with me; yet whilſt I ſtayed in it, that very ſtream, whoſe waters run ſo faſt away from me, waſhed and carried off whatever foulneſs it might find ſticking to my ſkin; and beſides, not only cooled me, and refreſhed me, by allaying the intemperate heat, that diſcompoſed me, and made me faint, but alſo helped me to a good ſtomach for ſome while after.

THUS (reſumes *Lindamor)* I have ſometimes found, that a moving ſermon, though it did not find me qualified to derive from it the advantages it queſtionleſs afforded better auditors; and when I went from it, I found I had retained ſo little of it, that it ſeemed to have almoſt totally ſlipt out of my memory, yet the more inſtructive and pathetick paſſages of it had that operation upon me, as to cleanſe the mind from ſome of the impurities, it had contracted by converſing to and fro in a defiling world, without ſuffering pollutions to ſtay long, and ſettle, where they began to be harboured: and beſides, I found that a courſe of ſuch ſermons, as I have been mentioning, did oftentimes (and if it had not been my own fault, would have always done ſo) both allay thoſe inordinate heats, that tempting objects are but too apt to excite; refreſh my drooping ſpirits, that continually needed to be revived, and raiſe in me an appetite to the means of grace, which are piety's (and conſequently the ſoul's) true and improving aliments. So that, (concludes *Lindamor)* though I ſeldom let ſermons do me all the good they may, and ſhould, yet I dare not forſake them, becauſe I forget them; ſince it is to do a man ſome good, to make him leſs bad than he was, and to give a value and inclination for the means of growing better than he is.

## DISCOURSE X.

### *Upon a fiſh's running away with the bait.*

THIS reflection of *Lindamor*'s was ſoon followed by another of the ſame gentleman's, who ſeeing many fiſhes riſe one after another, and bite at *Eugenius*'s bait, which he let them ſometimes run away with, that he might be the ſurer to be able to draw them up, as he afterwards did ſeveral of them; See, (ſays *Lindamor*, as one of the fiſhes had juſt ſwallowed the hook) how yonder ſilly fiſh, having at length ſeized the beloved bait he has been courting, poſts away with it as his obtained wiſh, little dreaming of being himſelf taken. Thus (continues the ſame ſpeaker) when greedy mortals have an opportunity to obtain forbidden things, they joyfully run away with them as the goods they aimed at, and when they fondly think they have caught, they are ſo; and whilſt they imagine themſelves to carry away a booty, they become a prey: for that he is, in his judgment that never errs, who, whatever he gets into the bargain, loſes himſelf.

THE Scripture (ſubjoins *Euſebius)* mentions, among other properties of vice, that which it calls the deceitfulneſs of ſin. And the wiſe man tells us, that wine is a mocker; and it may be one of the reaſons of theſe expreſſions, that when we think our ſelves poſſeſſed of a ſinful pleaſure, we are indeed poſſeſſed by it, as demoniacks are poſſeſſed by the devil, who ſerves many other ſinners, though leſs perceivedly, as he ſerves witches, whom he gets the power to command, by ſeeming to obey them, and to comply with their criminal deſires: and, if we compare this with what I was juſt now obſerving to you, on the occaſion of the counterfeit fly, we may add, that even when ſin ſeems the kindeſt and moſt obſequious to us, and to anſwer, if not exceed our deſires, our caſe may be but like the Canaanitiſh general's, who, though he had milk brought him by *Jael* inſtead of the water he only requeſted, was but thereby invited *to ſleep the ſleep of death*, and to have his fears more ſurpaſſed than his deſires had been.

Judges iv. 29.

BUT (purſues *Euſebius)* this may ſupply us with another reflection; for though this fiſh ſeems to have devoured the hook and bait it ſwallowed, yet in effect it is taken thereby: ſo the devil, when he had played the ſerpent and the lion, when he had brought the Jews and Gentiles to conſpire againſt their common Saviour, and had made *Herod* and *Pilate* friends, to make them joint enemies to Chriſt, and when by theſe means he ſeemed to have obtained his end, by employing their hands to kill the formidableſt of all his enemies; this purſued prey deſtroyed the ſeeming conqueror; and death appearing to ſwallow the Lord of life was, if I may ſo ſpeak, choaked by the attempt, ſince he not only was quickly able to ſay in the Apoſtle's triumphant language, *O death, where is thy ſting? O grave, where is thy victory? but did by death conquer him that had the power of death, that is, the devil:* nay, and made all his followers ſo much ſharers in the advantages of his conqueſt, as by the ſame way (which we are informed by the ſame text) to deliver thoſe, whom the reſtleſs fear of death perpetually kept from reliſhing the joys of life. 2 Cor. xv, 15. Heb. ii. 14, 15.

## DISCOURSE XI.

### *Upon a danger ſpringing from an unſeaſonable conteſt with the ſteerſman.*

THIS diſcourſe being ended, *Eugenius*, who was looked upon by us all as the moſt experienced as well as concerned angler among us, deſcrying at a good diſtance a place, which he judged more convenient for our ſport, than that we there were in, where the fiſh began to bite but ſlowly; he invited the company to this new ſtation: but when we were come thither, finding in a ſhort time, that either it was ill ſtocked with fiſh, or that the ſeaſon of their biting in the places thereabouts was over, he thought it concerned him to provide us ſome better place. And accordingly, whilſt we were yet, by the pleaſure of mutual converſation, endeavouring to keep the fiſhes ſullenneſs from proving an exerciſe to our patience, he walked along the river, till he lighted upon a youth, that by his habit ſeemed to belong to ſome boat or other veſſel; and having inquired of him, whether he could not be our guide to ſome place where the fiſh would bite quick, he replied, that he eaſily could, if we would take the trouble of coming to a place on the other ſide of the river, which his maſter, who was a fiſher-man, had baited over night, and would queſtionleſs let us make uſe of for a ſmall gratification. *Eugenius*, being very well content, called away the company, which were led by the youth to a boat belonging to his maſter; into which being entered, the old man, who was owner of the boat, hoiſted up ſails, and began to ſteer the boat with one of his oars, to a place he ſhewed us at a good diſtance off; but did it ſo unſkilfully, that ſince a mariner of his age could ſcarce miſtake ſo groſly for want of experience in the river, we began to ſuſpect, that he had too plentifully taſted a far ſtronger liquor than that which was the ſcene of his trade: and as the old man was half drunk, ſo the youth appeared to be a mere novice, both which we had quickly occaſion to take notice of. For ſome clouds that were gathering out of the ſea, paſſing over our veſſel, raiſed in their paſſage, as is uſual enough, a temporary wind, that to ſuch a ſlight boat as ours was might almoſt paſs for a kind of ſtorm: for then the old man gave his directions ſo ill, and the youth was ſo little able to execute them punctually, that two of the company, offended at their unſkilfulneſs, began by angry and unſeaſonable expoſtulations and clamours to confound the already diſordered boat-man; and being got up, with no ſmall hazard to the boat, they would perchance, by croſſing the watermen in their endeavours, have made it miſcarry, had not *Lindamor*, whoſe travels had made him well acquainted with ſuch caſes, earneſtly requeſted them to ſit ſtill, and let the watermen do their own work as well as they could; affirming, that he had ſeen more than one of thoſe eaſily over-ſet boats caſt away, by the confuſed and diſagreeing endeavours of the watermen and paſſengers to preſerve it. This counſel was thought very reaſonable, ſince the greater the wind was, and the leſs the ſteerman's dexterity, the more neceſſary it appeared, that we ſhould be orderly and quiet, and by leaning our bodies ſometimes one way, and ſometimes another, as occaſion required, do what in us lay to keep the veſſel upright: and herein we were ſo proſperous, that ſoon after the cloud was paſſed, and the ſhower it brought with it was over, the wind grew moderate enough to allow us to make ſome calm reflections on what had happened. This *Lindamor*, from the thanks that were given him for his advice, took occaſion to do in theſe terms: Since ſtateſmen and philoſophers are wont to compare a commonwealth to a ſhip, I hope the reflection ſuggeſted to us by what had juſt now happened, will be the eaſier pardoned. The ſkill of ruling nations is an art no leſs difficult than noble: for whereas ſtatuaries, maſons, carpenters, and other artificers work upon inanimate materials, a ruler muſt manage free agents, who may have each of them intereſts or deſigns of their own, diſtinct from thoſe of the prince, and many times repugnant to them: and the prizes, that are contended for in government, either are, or (which is in our caſe all one) are thought, ſo valuable, and the concurrents are ſo concerned, and conſequently ſo induſtrious to drive on each his own deſign, that without mentioning any of thoſe many other things, which make good government difficult, theſe alone may ſuffice to make it more our trouble than our wonder, that the rulers of ſtates and commonwealths ſhould oftentimes miſ-govern them. But the publick infelicities of declining ſtates are not always wholly due to the imprudence of the ruler, but oftentimes thoſe, that moſt reſent ſuch imprudency, even by thoſe very reſentments increaſe the publick diſorders they appear ſo much troubled at; and it may be a queſtion, whether it be more prejudicial to commonwealths, to have rulers, that are mean ſtateſmen, than to have a multitude of ſubjects, that think themſelves to be wiſe ones, and are forward to cenſure what is done by their magiſtrates, either becauſe it is done by their ſuperiours, or becauſe it is not done by themſelves.

YET it may well be doubted, (ſays *Eugenius*) whether the reverence and ſubmiſſion we owe to ſenates or princes extend to our very reaſons, and our inward thoughts: for the right, and the ſkill to govern, are two very diſtinct things: nor does the one confer the other. A crown, how precious ſoever, adorns but the outſide of the head, without enriching the inſide; and its ſplendour will ſcarce dazzle a wiſe beholder's eyes, though it but too often does theirs that wear it. No, the tribunal of reaſon has a juriſdiction, that reaches to thrones themſelves; and what you well obſerved juſt now, concerning the difficulty of avoiding faults in government, will, I preſume, make you think it excuſable, if I confeſs, that I think ſovereigns do now and then do, what you confeſs it is ſo hard for them to avoid doing; nor is it more a breach of loyalty, not to think a weak governour a prudent one, than not to think him tall, or ſtraight, or ſharp-ſighted, if nature have made him low, or crooked, or purblind. A ſenate or a monarch may indeed command my life and fortune: but as for my opinions, whether of perſons, or things, I cannot in moſt caſes command them my ſelf, but muſt ſuffer them to be ſuch, as the nature of the things I judge of requires; and therefore, the thinking all things done with wiſdom, that are done by men in power, is too great an impoſſibility to be a duty; and beſides, it would leſſen the merit of obedience, which otherwiſe would not appear to be paid to the authority of the magiſtrate, ſince we readily obey the injunctions of lawyers and phyſicians, as long as we think them prudently framed for our good, though we acknowledge not theſe perſons to have any right to command us.

BUT though (continues *Eugenius*) I take reaſon to be ſo ſupreme a thing, that as even the greateſt prince's actions ſhould be regulated by it, ſo they may be judged by it; yet I allow lawful authority a juriſdiction over my actions, that I deny it over my opinions: and though I can obey the orders, that have the impreſſes of wiſdom, as well as the ſtamp of authority, with more hope and alacrity, yet I can obey thoſe, wherein I think power is unguided by prudence, with no leſs punctualneſs and fidelity. I would not reſiſt a magiſtrate, when I cannot eſteem him: and though I dare diſcern folly even in the greateſt princes, yet I can reverence authority in the weakeſt.

I KNOW *Eugenius* too well (ſays *Lindamor)* not to believe him. But though I confeſs, that to do what you ſay, is to do much, and to do that, which I fear is not uſually done; yet methinks it were well if we did ſomewhat more. For whereas moſt human actions, eſpecially about matters political, are attended with great variety of circumſtances, according to ſome or other of which, they may be differingly conſidered, and eſtimated; as it is not very difficult to make many, if not moſt actions appear politick or unwiſe, according as they are cloathed with thoſe of their circumſtances, that may be applied to excuſe them, or with thoſe, that are fit to diſcommend them; ſo I would take a care to put the favourableſt conſtructions on thoſe publick counſels, that are capable of more conſtructions than one, and uſe the parents of my country, as *Noah*'s two dutiful children did their diſtempered father, whoſe nakedneſs when they had once diſcovered, they covered too; and that in ſuch a way, as ſhewed they were unwilling to ſee more of it, than was neceſſary to enable them to hide it. And I ſay this, (continues *Lindamor)* with relation to *Eugenius*, and ſuch as he; for as to the vulgar, who yet make up the far greateſt and loudeſt part of thoſe, that would intrude themſelves into ſtate-affairs, upon the pretence of their being ill managed by their ſuperiours: I cannot but think, that whatever the courſe of affairs be, theſe cannot but be incompetent judges of their being politick, or the contrary. For to judge of things barely by ſucceſs, were ſomewhat to forget, that there is a ſupreme and abſolute diſpoſer of events, and has been a practice always rejected by the wiſe, as both diſcouraging wiſdom, and affronting it. And as for the counſels, by which indeed the prudence or imprudence of publick actions is to be eſtimated, the vulgar is rarely admitted to have ſuch a proſpect into the true ſtate of affairs, as is requiſite to enable them to judge of the expedience or unadviſedneſs of them, being unacquainted with the frame and motives of the prince's counſels and deſigns. Ordinary men may often think that imprudent, whilſt they conſider it only in it ſelf, which its congruity to the reſt of the prince's deſigns may make politick enough; and a private whiſper, or the intimation from an unſuſpected ſpy, or an intercepted letter, or divers other things unperceived, and perhaps undreamt of, by thoſe, that are not of the ſtate-cabal, may make it wiſe to do ſeveral things, which to thoſe, that look only at the actions, without knowing the motives, may appear unpolitick, and would indeed be ſo, were it not for theſe reaſons, which yet ought to be as little divulged as diſobeyed. So that the people's forwardneſs to quarrel with the tranſactions of their prince, is uſually compounded of pride and ignorance, and is moſt incident to thoſe, that do not ſufficiently underſtand either ſtate-affairs or themſelves: and whilſt they judge upon incompetent information, even when their ſuperiours are in the fault, they may be ſo, for cenſuring them.

I MUST not now diſpute, (ſays *Euſebius)* whether ſuch as you, gentlemen, whom their conditions, parts and opportunities qualify to diſcern the intereſts and deſigns of princes, may not be allowed to judge of their counſels, and ſee their errors; as our late aſtronomers, being aſſiſted with good glaſſes, are allowed to tell us, that they diſcern ſpots even in the ſun it ſelf. But, certainly, the ambition of pragmatical inferiours to make themſelves ſtateſmen, upon pretence, that thoſe, who ſit at the helm, do not govern it as wiſely as theſe would do, if they were in the ſame places, is a fault no leſs prejudicial to any ſtate, than epidemical in ſome of them. For whilſt the government is thus decried, the ſame diſadvantageous repreſentations embolden ſtrangers and foreigners to attempt the ſubverſion of a ſtate, and make the deſpondent ſubjects deſpair of preſerving it; little conſidering, that there are ſcarce ever any imprudences in a government, that can prove any thing near ſo prejudicial to the generality of the ſubjects, as would the ſubverſion of it, whether by foreign conqueſt, or by inteſtine jars; ſuch changes ſeldom doing leſs than entail upon unhappy countries the fears and miſchiefs of war. And that though it be granted, that the right of governing does not confer the ſkill, yet it is much better to ſtick to the former, than oppoſe or deſert it, becauſe it wants the latter: for a right to a crown, is that, which for the moſt part manifeſtly belongs but to one, and is ſeldom plauſibly pretended to by above two or three; whereas the ſkill to govern is ſo undetermined, and ſo uncertain a thing, that men's innate pride and ſelf-love would incline almoſt every man to claim it for himſelf, eſpecially, ſince by challenging that, he might put in for no leſs than ſovereignty. And in a ſtate thus abandoned to the crafties or the ſtrongeſt, there would never want diſturbing viciſſitude of governments, as well as governours, ſince whoever could get intereſt enough in the ſoldiery, or the multitude, would quickly deviſe and impoſe ſuch a frame of government, as may put the management of affairs into his and his party's hands, and give them the authority, that have the power. But (reſumes *Euſebius)* I muſt remember, that not politicks, but divinity is my profeſſion, and therefore without enlarging upon the confuſion that is inevitable in a ſtate, where the right of governing being not heeded, or at leaſt not aſcertained, every man would pretend to counſel or command, and none would think himſelf bound to obey; I ſhall only mind you, that magiſtracy having been inſtituted by God for the good of mankind, we may in obeying our lawful magiſtrates, though perhaps leſs wiſe than we could wiſh them, not only participate the advantages naturally accruing from obedience to ſuperiors, but divers peculiar bleſſings, that God oftentimes vouchſafes to our obedience to his vicegerents, and his inſtitutions. Let ſubjects therefore (ſays *Euſebius)* wiſh for wiſe princes, but ſubmit to thoſe, the providence of God, and the laws of their country, may have given them: let us, if by any juſt way we be called to it, aſſiſt a prince with the wiſeſt counſels we can; if not, let us aſſiſt him to make the beſt of the unwiſe counſels he has taken, without adding our factiouſneſs or our paſſions to his miſgovernment; remembering, that, at leaſt in my opinion, to the happineſs of a commonwealth it is not only requiſite, that the prince know how to command well, but that the ſubjects obey well; and that even weak counſels, faithfully aſſiſted, and as much as may be rectified or repaired by thoſe, that are to execute them, may leſs prejudice the publick, than the forward and jarring endeavours of men, that perhaps would be wiſer rulers, if they had a right to be ſo. It may be (continues *Euſebius)* that affection and diligence in the publick ſervice may, in ſpite of the government's miſcarriages, prevent, or at leaſt retard and leſſen, the ruin of the ſtate. But however, (concludes he) it will be no ſmall ſatisfaction to an honeſt man, and a loyal ſubject, not to be conſcious to himſelf of having contributed to the publick calamities, either by his own provocations, or his factious indignation at the prince's faults. If a man have done his utmoſt to hinder the ruin he comes to be involved in, the publick calamity will be far lighter to him, being not clogged by private guilt; and he will ſupport the miſfortune of it with far the leſs trouble, if he be to ſupport nothing elſe. Nay, ſince the ſervice we do to whatever prince is rightfully ſet over us, upon the ſcore of his being God's vicegerent, is ultimately directed to that ſupreme, and, as the ſcripture calls him, only potentate, whoſe magnificence is as inexhauſted as his treaſure; we may ſafely expect, that whatever prejudice we here ſuſtain upon the account of the prince's commands, will hereafter be advantageouſly conſidered to us in the reward of our obedience.

## DISCOURSE XII.

### *Upon clouds riſing out of the ſea, and falling down in rain not brackiſh.*

THIS diſcourſe had already laſted ſo long, that as well my unwillingneſs, that one theme ſhould detain us any longer, as my deſire to keep *Eugenius* from making any reply, which on ſuch an occaſion might, perchance, have begot ſome diſpute, made me forward to divert the diſcourſe, by inviting the company to take notice of a black cloud, that was coming towards us; which ſoon after, in its paſſage under the ſun, interpoſed betwixt our ſight and that glorioueſt object of it. *Lindamor* then having a while attentively enough conſidered it, took thence an occaſion to ſay, This cloud, gentlemen, whenſoever it ſhall fall down in rain, will ſufficiently ſhew, that it was before but water, which whilſt it lay mingled with the reſt of the river, or ſea, whence it is exhaled, may be ſuppoſed as clear and limpid as any of the reſt; but now that the ſun has by its powerful beams elevated this water in the form of vapours, and drawn it near it ſelf, we ſee, it compoſes a cloud, which does no longer receive or tranſmit the light, but robs the earth of it, and eclipſes the ſun that raiſed it; and ſometimes too produces diſmal ſtorms of rain, and wind, and hail. Thus (purſues *Lindamor*) there are many, who while they continued in a low and private fortune, were as blameleſs as others; and yet, when by a peculiar vouchſafement of providence, they are raiſed from that humble ſtate to a conſpicuous height, they ſeem to have as much changed their nature as their fortune; they grow as much worſe than meaner men, as their condition is better than that of ſuch; and the principal things, by which they make their exaltation be taken notice of, are, the prejudice they do to their inferiours, and the ingratitude they excuſe towards that monarch of the world, that raiſed them above others. Of ſo perverting a nature is ſo high a ſtation, that the gaining of an earthly crown is very far from being a furtherance to the acquiring of an heavenly one; and many, whom an humble condition of life kept as innocent as lowly, are, by the higheſt advancement in point of fortune, impaired in point of morality; and theſe ſupreme dignities, which the ambitious world ſo fondly courts and envies, do ſo often manifeſt thoſe, that have attained them, to be unworthy of them.

I KNOW not whether *Eugenius* imagined, that *Lindamor* did in this diſcourſe make ſome little reflection upon what we had lately ſaid on the behalf of princes: but I afterwards ſuſpected, that it was partly to reply to this obſervation, as well as entertain the company with a new one, that he ſubjoined; as this cloud has furniſhed *Lindamor* with one reflection, ſo that, which lately brought us the ſhower of rain, whoſe marks are yet upon our hats, may ſupply us with another, which may ſhew, that themes of this nature are applicable to very differing purpoſes, according as one or the other of their circumſtances happens to be conſidered and employed: for as far (purſues he) as we can judge by the neighbourhood of the ſea, and by that cloud's being driven hither by a wind blowing thence, it conſiſted of the ſea-water raiſed in the form of vapours. But though the water of the ocean is ſalt and brackiſh, unpleaſant and unwholeſome, whilſt it lies there unelevated; yet that water, which has the advantage of being raiſed to the ſecond region of the air, appears, when it is turned into rain, to have left all its brackiſhneſs behind it, and proves both wholeſome for men's bodies, and fertilizing to their fields.

THUS (continues *Eugenius*) we ſometimes ſee, that men, who in a private condition were ſubject to divers vices, diveſt them, when they are advanced to the honour of putting on royal robes; as ſilk-worms leave their huſks behind them, when by acquiring wings they turn into (a nobler ſort of creatures) flying animals. As moſt men change, ſo ſome improve their minds with their condition, and ſeem to have miſbehaved themſelves in a lower ſtation; but becauſe they were born to a higher, and were, whilſt beneath it, detained out of their proper ſphere. And indeed, as a throne expoſes thoſe that ſit on it to peculiar temptations to vice, ſo does it afford them peculiar engagements to virtue; as ſo elevated a ſtation is apt to make men giddy, ſo is it proper to make them circumſpect, by letting them ſee, that all the world ſees them: the ſublimity of ſuch a condition would make any ſoul, that is not very mean, deſpiſe many mean things, that too often prevail upon inferiour perſons. If princes have any ſenſe of ſhame and honour, it will be a great curb to them, to conſider, that, as there are too many eyes upon them to let their vices be ſecret, ſo their faults can as little eſcape cenſure as diſcovery; and men will be the more ſevere to their reputations, becauſe it is the only thing, wherein ſubjects can puniſh their ſovereigns. If they have any thing of generoſity in their natures, their very condition, by placing them above other objects, will make them aſpire to glory; and that is a miſtreſs, that even monarchs cannot ſucceſsfully court, but with great and good actions. And if they have withal a ſenſe of piety, they cannot but in gratitude to him, whoſe vicegerents they are, endeavour to promote his intereſts, that made them ſo; and ſo make themſelves as like him as they can, in his other attributes of clemency, juſtice, and bounty, as he has vouchſafed to make them in his power and authority. And beſides, that the actual poſſeſſion of an earthly crown leaves them nothing worth aſpiring to, but a heavenly one; the conſideration of the great advantages they have above other men of doing good, and the exemplarineſs and influence as well of their vices as of their virtues, will make them tremble at the thoughts of the account they muſt one day render of ſo many thouſands, perhaps of ſo many millions (of ſubjects) committed to their charge; if, as they are ſure it will be a great one, they ſhall not make it a good one. Nor (purſues *Eugenius*) is hiſtory altogether unfurniſhed with examples of thoſe, whom a throne has as well improved as dignified. *Saul* was not the only perſon, who, when he was created king, had another ſpirit, and became another man. That *Titus*, who was the head of it, was juſtly ſtyled the darling of mankind, though his virtue and nobleneſs did, more than his crown, keep the greateſt part of poſterity from taking notice of any thing in him, but an obligingneſs proportionate to his greatneſs; yet I find in ſome ancient writers, to whom truth was more dear than even this favourite of mankind, that before he came to that ſupreme pitch of human dignity, his courſe of life did not promiſe the Roman world the happineſs it derived from his government; his life, before he came to be Emperor, having not been ſo free from blemiſhes of luſt and blood: but that I may, in writing his character, invert what the Roman hiſtorian ſaid of one of his predeceſſors, and ſay, that *Titus* had been thought *indignus imperio, niſi imperaſſet.* And, without going as far as *Rome*, our own hiſtory affords us a *Henry* the fifth, who, before he came to the kingdom, was ſcarce thought worthy to live in it, and did ſo degrade himſelf to the practices of the meaneſt malefactors, that a judge, that was then his father's ſubject, was fain to uſe him at that rate; and yet this prince, as ſoon as he had ſeated himſelf in the throne, did as ſuddenly, as if the place it ſelf had ſome ſecret virtue to improve thoſe it admitted, behave himſelf as a perſon worthy of it; and not only conquered *France*, but, which was a nobler, as well as a more difficult victory, his own reſentments too, by prefering that judge, when king, that had impriſoned him, when prince; and evincing by

1 Sam. x. 6, 9.

ſo memorable an action, that he preferred virtue above himſelf, and renouncing the pleaſure of revenge, he ſcrupled not to promote one, whom he could not commend without condemning himſelf; were it not, that in this prince, according to what I was ſaying, the king was become another man than the ſubject. And perhaps, (concludes *Eugenius*, a little ſmiling) I could proceed to give you other examples enough to keep it from being improbable, that one main reaſon, why there are but few good princes, is, becauſe there are but few princes; were it not, that I ſee the waterman prepare to land us. And in effect, we are now come ſo near the place, where the fiſherman deſigned to ſet us aſhore, that whether or no *Lindamor* had a mind to return any thing to what *Eugenius* had ſaid, it would then have appeared unſeaſonable, either to reſume the debate, or proſecute the diſcourſe.

## DISCOURSE XIII.

### *Upon drawing the boat to the ſhore.*

WHEN we were now come to the place, where we were to be landed, leſt the boat ſhould be carried away by the ſtream before we could ſtep aſhore, the owner of it reached out his long pole, and by means of the crook, taking faſt hold of the bank, he drew the pole towards him with all his might, and thereby brought the boat to ſhore. This endeavour of the water-man's, and the effect of it, inviting *Euſebius* to ſmile a little, gave me the curioſity, as ſoon as we were landed, to inquire, why he did ſo. It is almoſt as ordinary (anſwers *Euſebius*) for men to think themſelves wiſer than God, as it is impoſſible for them really to be ſo. Thoſe, that ſtudy nothing but to obtain their ends, and that ſcruple at nothing they judge conducive to them, do oftentimes lay their deſigns and plots with ſo much artifice and ſubtilty, that they do not doubt, that, whatever may become of God's deſigns, and of his promiſes, and threats, thoſe, which themſelves have laid ſo politickly, cannot but ſucceed. And even pious and well-meaning perſons, that have the opportunity to diſcern the politick ways, that theſe men take to compaſs their ends, are oftentimes tempted to needleſs fears, that divine providence will be puzzled and diſtreſſed by them; and to think, that, for reaſons ſecret, though juſt, providence may be put by theſe men's craft to play an after-game in the world to come. But in ſuch caſes, it often fares with theſe grand deſigners, as it did juſt now with our water-man: he had faſtened his grapling-iron to the ſhore, and putting to his utmoſt ſtrength, did ſo forcibly endeavour to draw it towards him, that one, that did not know that the ſhore was fixt, might expect this luſty fellow's endeavours capable to put into motion whatever he ſo forcibly drew towards him: but the ſhore being fixt, and immoveable, inſtead of making that come to him, his very ſtrainings drew him and his boat to that. Thus the contrivers of the proud pile of *Babel*, whereby they meant (not as moſt imagine, to ſecure themſelves againſt a ſecond flood; the text being ſilent as to that aim, and a plain being a very improper place for ſuch a purpoſe, but) to make themſelves a name, and prevent diſperſion; theſe ambitious contrivers, who had laid their plot ſo hopefully, that they had engaged no leſs than mankind, and who probably had deſigns as raiſed as their intended fabrick, ſince thoſe expreſſions of him, that knew their hearts, *(And this they begin to do, and now nothing will be reſtrained from them, which they have imagined to do)* ſeemed, methinks, to warrant my conjecturing, that thoſe had deſigns very aſpiring, that intended but to make a riſe to their ſoaring flight of a tower, whoſe top ſhould reach unto heaven. But the policy of theſe ambitious builders being contrary to the charitable decree of God, to have the earth peopled, he made uſe of that very conſpiracy, that brought them together, to effect that, Gen. xi. 6.

which they conſpired to prevent; ſo that now the remoteſt parts of the inhabited world are but the colonies of *Babel*, whoſe ſcattered architects have indeed made themſelves a name, but upon a quite contrary account than they intended or expected. Thus the purblind envy of *Joſeph's* brethren, having made them reſolve to prevent his future dreams of ſuperiority over them, made them think, that, by ſelling him for a ſlave, they had taken ſufficient order he ſhould never come to be their maſter. And yet we ſee, that *Joſeph's* being ſold into *Egypt* was made uſe of by the wiſe orderer of human affairs, to make him in effect Lord of that rich and populous kingdom, and thereby, of his envious brethren, *Pharoah*'s dreams having advantageouſly made him amends for the hardſhips his own had expoſed him to. So the proud favourite of *Ahaſuerus*, queſtionleſs, thought he could ſcarce miſs his ends, when, by the counſel of his friends, and, as he fondly thought, of his gods too, he provided for *Mordecai* that fatal gibbet, which probably he might have eſcaped, if he had not erected it. Thus the high prieſt, and the ſanhedrim of the Jews, ſeemed to act with much policy, though no juſtice, when they reſolved upon the death of our Saviour; leſt, as the Goſpel tells us, the Romans ſhould come and deſtroy their temple, and nation; which, whether indeed it did not rather procure, than divert the coming of the Romans, the church-hiſtory can inform you. Nay, the old ſerpent himſelf, that arch-politician, that was the inſtructor of thoſe others I have been naming, even in his chiefeſt maſter-piece, found himſelf the moſt over-matched by him, to whom the Scripture aſcribes the taking of the wiſe in their own craftineſs. For, queſtionleſs, he highly applauded his own ſubtilty, and ſeemed to have taken the directeſt, and moſt proſperous way to his impious ends, that could be deviſed; when, having made *Herod* and *Pilate* friends, upon ſuch terms, that the Lamb of God ſhould be the victim of their new confederacy, he had engaged both Jews and Gentiles in a ruinous and tragick conſpiracy, to kill the prince of life, and, by that unparalleled crime, at once deſtroy the devil's chief enemy, and make God their's. And yet the event has ſufficiently manifeſted, that the Apoſtle might well affirm, that Chriſt, by his death, deſtroyed him, that had the empire of death, the devil; and that Satan's kingdom never received ſo deadly a wound, as that which pierced our crucified Saviour's ſide. Wherefore, in ſhort, (concludes *Euſebius*) the decrees of providence are too ſolid and fixed, to have violence offered them by human attempts, how ſpecious ſoever they be; and thoſe, that think to bring God to their bent, will find, at long running, that they have to do with one, whoſe power and wiſdom are ſo over-ruling, that not only he can fruſtrate their utmoſt endeavours, but make thoſe very endeavours fruſtrate themſelves, and employ men's ſubtileſt policies, to accompliſh thoſe very things they were deſigned to defeat.

## DISCOURSE XIV.

### *Upon catching ſtore of fiſh, at a baited place.*

AS ſoon as we were come to the place the fiſherman told us of, we found it as plentifully ſtored with fiſh, as he had foretold us; and caught more in ſome few minutes, than we had taken in a whole hour before: but we did not half ſo much marvel at this, as we were pleaſed with it, becauſe the fiſherman informed us, that he had liberally baited the place over-night with corn, as well as worms. Whilſt this pleaſant exerciſe laſted, *Euſebius*, marking how great a reſort of fiſhes there was in that place, and how faſt we drew them up, upon comparing what he ſaw happen with the occaſion of it, thus acquainted us with the thoughts thereby ſuggeſted to him. Thoſe (ſays he) that yeſterday in the evening might ſee this man (pointing at the fiſherman) throw in his baits by handfuls into this place, and then depart, as minding them no more, were probably, if they knew not his deſign, and the cuſtom of fiſhers, tempted to think him a waſteful prodigal, or, at beſt, a venturous fool, to bury his corn in the river, and throw his baits to be caught up by fiſhes, that, for aught he knew, would never come back to thank their hoſt. But thoſe, that know (what we now find) how profitable a courſe this is wont to prove, would, inſtead of thinking ſuch a practice a piece of folly, look upon it as a piece of providence: for though he be ſure not to recover, in kind, the things he caſt upon the waters, yet ſuch a loſs is wont to prove very gainful unto him, whilſt he loſes but a grain of corn, or a worm, to obtain fiſhes of far more value. Thus, though the purblind world may think a liberal alms-giver, or a generous confeſſor, a fool, or a prodigal, whilſt they only conſider him as one, that throws away what he has in preſent poſſeſſion, and ſeems not ſo much as to hope for the recovery of the ſame goods, or any of the like nature; yet thoſe, whoſe eyes being illuminated with a heavenly light, are thereby enabled to look into the vaſt and diſtant regions of the future, and to deſcry there the final iſſues of all temporal things, will be ſo far from thinking him unwiſe, for parting with unſatisfying trifles, to procure the higheſt and moſt permanent goods, that they will think his proceedings far more juſtifiable, in point of prudence, than we now think the fiſherman's: nor will the parting with a greater fortune, as freely as with a leſſer, any more alter the caſe, than the fiſherman's throwing in his bigger worms, and grains of corn, with no more ſcruple than his leſſer. For heaven does as well incomparably out-value the greateſt, as the leaſt goods, poor mortals can lay out for it; and he, who has all things to give, and is infinitely more than all himſelf, has promiſed, that thoſe that ſow plentifully, ſhall reap ſo too; and though the leaſt of future acquiſts would incomparably tranſcend the greateſt price, that can be here given for it, yet the future rewards will, betwixt one another, bear a proportion to the occaſions of them. And, as the fiſherman is ſure to loſe what he throws into the water, and is not ſure to get by it any thing of greater value than ſome fiſhes, the Chriſtian adventurer (if I may ſo call him) may hope, though not confidently promiſe himſelf, in this world, the hundred-fold mentioned by our Saviour, as well as in the world to come life everlaſting. And therefore, if we do indeed, in St. *Paul*'s language, look, not to the things, which are ſeen, which are but temporary, but to the inviſible ones, which are eternal, we ſhall think that exhortation of his very rational, as well as very pious, where, having diſcourſed of the future and glorious ſtate of the true Chriſtians, he concludes, *Wherefore, my beloved brethren, be ye ſtedfaſt, immoveable, always abounding in the work of the Lord; for as much as you know, that your labour is not in vain in the Lord.*

## DISCOURSE XV.

### *Upon the magnetical needle of a ſun-dial.*

WE had not yet diſmiſſed the waterman, when *Eugenius*, chancing to expreſs a curioſity, to know what o'clock it was, when we had freſhly begun to angle at our new ſtation; as *Lindamor* and the reſt drew their watches to ſatisfy his queſtion, ſo the boat-man took out of his pocket a little ſun-dial, furniſhed with an excited needle, to direct how to ſet it, ſuch dials being uſed among mariners, not only to ſhew them the hour of the day, but to inform them from what quarter the wind blows. Upon the ſight of this dial, my natural curioſity invited me, after it had told me the hour, to try, whether the magnetick needle were well touched, by drawing a little penknife out of a pair of tweezes I then chanced to have about me, and approaching it to the north point of the needle, which, according to the known cuſtom of ſuch needles, readily followed it, or reſted over-againſt it, which way ſoever I turned the penknife, or whereabout ſoever I held it ſtill. *Euſebius* ſeeing me give my ſelf this diverſion, came up to me to be a ſharer in my ſight, which no familiarity can keep from being a wonder: but, after a while, he looked upon it in a way, that made me think it preſented him ſomewhat elſe than the hour of the day, or the corner of the wind; and I was confirmed in that thought, by ſeeing him apply to it the caſe of *Lindamor*'s watch, and then a diamond-ring, plucked from his own finger, and, in effect, he ſoon began to tell me; Methinks, *Philaretus*, this needle may afford us a good direction in the choice of companies; and that is a matter of ſuch moment, that ſome divines perhaps would queſtion, whether or no the direction it gives navigators, to find the poles, be of much greater importance. For not only it has been truly obſerved, that the choice of one's company does exceedingly diſcover, whether a man be good or bad, wiſe or fooliſh; but I ſhall venture to add, that it does very much contribute to make him what others ſay it declares him: for an aſſiduous converſe does inſenſibly diſpoſe, and faſhion our minds and manners, to a reſemblance with thoſe we delight to converſe with; and there are few, that have ſo much reſolution, as to diſobey cuſtoms, and faſhions, eſpecially when embraced by perſons, that we love, and would be eſteemed by, and from whoſe opinions, and practices, we can ſcarce diſſent conſtantly, without impreſſing a diſlike, that threatens to make them diſlike us. For my part, (ſays *Lindamor*) I have always thought, there is great difference betwixt keeping company with ſome men, and chuſing to do ſo; for, whilſt we live in this world, we muſt often have to do with the lovers of the world: but though to be caſt, by the exigencies of our callings, upon bad company, be an infelicity without being a fault, yet certainly, to chuſe ſuch company, and prefer it before that of wiſe and good men, is, in a high degree, both the one and the other. And I confeſs, (continues he) I cannot think, that the proper uſe of converſation is but to paſs away our time, not to improve it.

You are certainly much in the right (ſubjoins *Euſebius*) for though too many of thoſe, that are now cried up for good company, do either ſo diſſuade us from good and ſerious things, or ſo divert us from them, that it is oftentimes counted a piece of indiſcretion, to ſay any thing, that may either enrich men's underſtandings, or awaken their conſciences; yet I cannot but think, that converſation may be, as well as ought to be, reſcued from being an inſtrument to promote idleneſs and vice: and, if men were not wanting to themſelves, I doubt not, it may be ſo ordered, that converſation, which ſo often robs men of their time, and ſo frequently of their devotion, might be made a great inſtrument of piety, and knowledge, and become no leſs uſeful, than it is wont to be pleaſant.

To make companies (replies *Lindamor*) ſuch as you think they may be, they muſt grow very different from what moſt commonly they are: for, not to ſpeak of thoſe looſe and profane ones, where virtue and ſeriouſneſs are openly derided; and any thing, how contrary ſoever to piety, or right reaſon, may be uſed, not only with toleration, but applauſe, if men can bring it out, I ſay not in jeſt, (for they are ſeldom more in earneſt) but neatly wrapt up in raillery; even in thoſe civiller ſorts of company, where vice is not profeſſedly maintained, you ſhall ſeldom, during a long ſtay, hear any thing, that is really worth carrying away with you, or remembering when you are gone. And, to diſcourſe of any thing, that is grave enough, either to exerciſe men's intellects, or excite their devotion, is counted a piece of indiſcretion, that is wont to be more carefully avoided, than almoſt any thing that is really ſuch; ſo that, even in ſuch companies, the innocenteſt uſe, that we are wont to make of our time, is to loſe it. And really (continues *Lindamor*) when I conſider, how enſnaring the worſer ſort of companies are, and how little even thoſe, that do not openly defy piety and knowledge, are wont to cheriſh either of them; I begin to be reconciled to hermites, who fly from ſuch converſations, as are ſo apt to make men either vicious, or at leaſt idle, into thoſe ſolitudes, where they are not like to be tempted, either to renounce their devotion, or to ſuppreſs it, to entertain idle thoughts, or ſtifle good ones. Nor could I, without much ſcruple, as well as impatience, allow my ſelf to ſpend ſome part of my time in ſuch kind of entertainments, as many ſpend moſt of their's in, were it not, that looking upon civility as a virtue, and hoſpitality, as in ſome caſes a duty, and upon both of them as things of good report, I can think thoſe hours, they make me ſpend, may be juſtly caſt upon their account, and that the ceremonious and inſignificant converſations, whereto they oblige me, may be undergone upon ſome ſuch account, as that, on which ſerious parents converſe, and often-times play with their children. For as, though the things they do, are in themſelves trivial, and uſeleſs, yet they may be juſtifiable effects of a paternal care to ſtill a child, or keep him from harming himſelf; ſo the duty of exerciſing of civility makes me look upon as juſtifiable, though unpleaſant, thoſe expreſſions of it, which in themſelves conſidered, I could not reflect on without indignation, and could not but think very much below any man, whom education has fitted for the exerciſe of reaſon, or whom religion has elevated to the hopes of heaven.

BUT it may (ſays *Euſebius*) on the other ſide be repreſented, that ſince it is ſcarce poſſible not to meet ſometimes with companies, that are not of the beſt ſort, we ſhould look upon thoſe neceſſities, as calls of providence, to improve thoſe opportunities for the advantage of them we are ingaged to converſe with: for nature, as well as Chriſtianity, teaches us, that we are not born only for ourſelves, and therefore, as we ought often to converſe with the beſt men, to acquire virtue and knowledge; ſo we muſt ſometimes converſe with others, that we may impart them, and learn how much we are beholden to God's goodneſs, that has ſo much diſcriminated us from other men. And though we do not find, that our converſation does immediately and viſibly reform thoſe we converſe with, yet it will not preſently follow, that it is altogether ineffectual on them: for, beſides that the ſeeds of virtue and knowledge, as well as thoſe of plants, may long ſeem to lie dead, even in theſe ſoils, wherein they will afterwards flouriſh and fructify, there may be at preſent a good, though not a conſpicuous, effect of your diſcourſe and example. For when men are haſting to hell, he does them no ſmall ſervice, that does ſo much as retard their courſe; as cordials, and other medicines, may do good even to decrepid old men, whom they cannot perfectly cure.

AND truſt me, *Lindamor*, it is no ſuch uſeleſs performance as you may think it, for a man of known piety and parts, by converſing with the children of this generation, to dare to own religion among thoſe that dare to deride it; to keep alive and excite a witneſs for God and good things in their conſciences; to let them ſee, and make them (at leaſt inwardly) acknowledge, the beauty of a pious, induſtrious, and well-ordered courſe of life; to convince them, that it is not for want of knowing the vanities they doat on, that he deſpiſes them; to ſhew, that a man that denies himſelf their ſinful jollities, can live contented without them: and, (to diſpatch) to manifeſt, by a real and viſible demonſtration, that a virtuous and diſcreet life is no unpracticable, no more than melancholy thing, even in bad times, and among bad men. And, ſays *Euſebius*, to me it ſeems very conſiderable, that our Saviour himſelf, the great author of our faith, and exemplar of our piety, did not chuſe an anchorite's, or a monaſtick life, but a ſociable and an affable way of converſing with mortals, not refuſing invitations, even from publicans, or to weddings, and by ſuch winning condeſcenſions gained the hearts, and thereby a power to reform the lives, of multitudes of thoſe he vouchſafed to converſe with.

OTHER conſiderations (purſues *Euſebius*) might be repreſented to the ſame purpoſe with theſe: but ſince I promiſed you ſomething of direction, I ſuppoſe you will expect I ſhould tell you not what I *could* ſay, but what I *do* think. I will tell you then in few words, that though I think it as well poſſible as fit for men of radicated virtue, and fine parts, to make ſometimes a good uſe of bad company, eſpecially when their lawful occaſions caſt them into it: yet, for others to be often ingaged in ſuch company, though it may be but an infelicity, is a very great one; and to chuſe ſuch company, is, what is worſe than an unhappineſs, a fault. But generally ſpeaking, I would diſtinguiſh three ſorts of companies: for there are ſome, that not only are unable to improve me, but are unwilling to be improved themſelves. A ſecond ſort there is, that are as well ready to learn, as able to inſtruct: and there are others, that, though they are not proficients enough to teach me things worth my learning, are yet deſirous to be taught by me the little, that I know, and they ignore. Now, as the magnetick needle we were looking on, and which affords us the theme of this diſcourſe, if you ſhould apply a load-ſtone to it, would be moſt powerfully attracted by that, becauſe it can receive freſh virtue from it; and even, if you approach a piece of ſteel to it, the needle will, though not ſo ſtudiouſly, apply itſelf to it, from which, though it receives no magnetick virtue, it can impart ſome to it; but if you offer it the ſilver caſe of your watch, or the gold, that makes up your ring, or the diamonds that are ſet in it, none of all theſe, how rich or glittering ſoever, will at all move the needle, which ſuffers them to ſtand by it unregarded: ſo I ſhall, with the utmoſt cheerfulneſs, and application, ſeek the company of thoſe, that are qualified to impart to me the virtue or the knowledge they abound with. Nor ſhall I refuſe to entertain a ſociety with thoſe few, that being ſuch ſmall proficients as to need to learn of me, are alſo forward to do ſo. But thoſe, that can neither teach me any thing, that is good, nor are diſpoſed to let me teach them, how great a ſhew ſoever they make among thoſe, that make choice of their companions by their eyes; I may be caſt upon their converſation, but ſhall very hardly chuſe it.

## DISCOURSE XVI.

### *Upon the quenching of quick-lime.*

I HAD almoſt forgot to relate, that not far from the place, where we went on ſhore, and which we had not yet quitted, we ſaw divers heaps of quick-lime, ſome ſmoking, and ſome, that had not yet been drenched in water; and upon inquiry of thoſe, that looked to it, we were ſoon informed, that the conveniency of the neighbouring river, both for ſlacking of lime, and conveying mortar, had made the owners bring their lime thither, to be tempered and made fit for the reparation of ſome houſes, that we ſaw a little way off: but while we were talking, one of the workmen began to throw water upon one of the heaps, that had not yet been ſlacked, and afterwards poured on ſo much more as ſerved quite to drown the lime; and *Euſebius* marking, both what he did, and what enſued upon it, took thence occaſion to ſay to us; he, that ſhould ſee only the effect of the firſt effuſion of cold water upon quick-lime, would think, that by a kind of antiperiſtaſis, the internal heat of the lime is rather increaſed than ſuffocated by the coldneſs and moiſture of the water: for that, which before was not taken notice of, to manifeſt any ſenſible warmth, as ſoon as its enemy, the water, begins to invade it, acquires a new heat and new forces in the conflict, and not only ſhews a great impatience, or enmity, to that cold liquor, by acting furiouſly upon it, and throwing off many parts into the air, but prevails ſo far as to heat that cold element itſelf, to that degree, as to make it ſmoke and boil. But this conflict is ſeldom near ſo laſting as it is eager; for if you have but the patience to ſtay a while, you ſhall ſee the lime, after it has ſpent its occaſional ardour, and after its fire is quenched, lay quietly with, nay under, the water, as cold and as moveleſs as it. Thus, when a devout man (eſpecially if his fervour be adventitious from education, or cuſtom, as the fire in the lime from the calcination) firſt falls into the company of perſons, either profane, or otherwiſe groſly vicious, we often ſee, that his zeal, inſtead of being ſmothered by ſuch a rude and unaccuſtomed oppoſition, ſeems rather to be excited and kindled thereby, and poſſibly ſeems more likely to impart the warmth of his devotion to its enemies, than to loſe any of it himſelf; but when he is conſtantly, or at leaſt frequently, ſurrounded with ſuch company, you will too often ſee him loſe as well his own ardour as the endeavours of communicating it; and with thoſe very perſons, that did at firſt kindle and exaſperate his zeal, you ſhall at laſt ſee him live very quietly, and perhaps manifeſt as little of religious warmth as they; and that, which at firſt did ſo ſtrangely exaſperate and diſcompoſe him, becomes after a while ſo familiar, as not at all to move him.

## DISCOURSE XVII.

### *Upon one's talking to an echo.*

WE had poſſibly dwelt longer upon ſuch reflections, had I not been ſuddenly diverted by the repeated clamours of a voice, which each of us imagined he had very often heard: whereupon, as it were by common conſent, we began to look round about us, to ſee if any of our little company were miſſing; and finding that *Eugenius* was ſo, we readily concluded the voice we heard, though ſomewhat altered by diſtance, and other circumſtances, to be his; and accordingly we haſted towards the place, whence we judged the voice to proceed, that in caſe he were in any diſtreſs, or had met with any diſaſter, we might reſcue or relieve him: but when he came near, we could now and then diſtinctly hear him ſpeak ſome words ſo loud, and yet ſo incoherent and unable to complete a ſenſe, as if he meant, that all thereabouts ſhould hear him, and no body underſtand him. This made us double our curioſity, and our pace, till at length we deſcried him all alone in a ſolitary corner, wherein yet his loudneſs kept us from believing he ſought privacy: but as ſoon as he diſcovered us, he ſeemed both ſurprized and troubled at it. Coming to meet us, he firſt begged our pardon, if having been louder than he thought, he had put us to a trouble he did not intend; and then laughing, aſked us, if we did not think him mad: but *Euſebius* ſmiling told him, that before we could anſwer that queſtion, we muſt aſk one of him, which was, what he had been doing? Whilſt you, (anſwers *Eugenius)* were (I doubt not) better employed, my natural curioſity ſeduced me to ſpend ſome time in ranging about the places near the river-ſide; and as I was paſſing by this field, the accidental lowing of an ox made me take notice, that this neighbouring hill and wood furniſh this place with an excellent echo, which I at firſt tried only by whooping and hollowing; but afterwards diverted my ſelf by framing my queſtions ſo, as to make that babling nymph (for ſo you know the poets will have Echo to be) to diſcourſe with me.

For my part, (ſays *Lindamor)* I ſhould by no means like her converſation, becauſe that two qualities ſhe has, which to me would very much diſcommend it: and to prevent our aſking him what thoſe qualities were, one of them, (ſays he) is, that ſhe vouchſafes to diſcourſe indiſcriminally with all comers that talk to her, provided that they make noiſe enough.

You are much in the right, (ſays *Eugenius)* for that eaſineſs of admitting all kind of company, provided men have boldneſs enough to intrude into ours, is one of the uneaſieſt hardſhips, (not to ſay martyrdoms) to which cuſtom has expoſed us, and does really do more miſchief, than moſt men take notice of; ſince it does not only keep impertinent fools in countenance, but encourages them to be very troubleſome to wiſe men. The world is peſtered with a certain ſort of praters, who make up in loudneſs what their diſcourſes want in ſenſe; and becauſe men are ſo eaſy-natured, as to allow the hearing to their impertinencies, they preſently preſume, that the things they ſpeak are none; and moſt men are ſo little able to diſcern in diſcourſe betwixt confidence and wit, that like our echo, to any that will but talk loud enough they will be ſure to afford anſwers. And, (which is worſe) this readineſs to hazard our patience, and certainly loſe our time, and thereby incourage others to multiply idle words, of which the Scripture ſeems to ſpeak threateningly, is made by cuſtom an expreſſion, if not a duty, of civility; and ſo even a virtue is made acceſſary to a fault.

For my part, (ſubjoins *Eugenius)* though I think theſe talkative people worſe publick grievances than many of thoſe, for whoſe prevention, or redreſs, parliaments are wont to be aſſembled, and laws to be enacted; and though I think their robbing us of our time as much a worſe miſchief than thoſe petty thefts, for which judges condemn men, as a little money is a leſs valuable good, than that precious time, which no ſum of it can either purchaſe or redeem; yet I confeſs, I think, that thoſe of our great lords and ladies, that can admit this ſort of company, deſerve it: for if ſuch perſons have but minds in any meaſure ſuited to their qualities, they may ſafely, by their diſcountenance, baniſh ſuch pitiful creatures, and ſecure their quiet, not only without injuring the reputation of their civility, but by advancing that of their judgment. And I fear, (continues *Eugenius)* that thoſe, who decline this imployment (and indeed improvement) of their titles, or other kinds of eminency, do, by their remiſſneſs, more harm than they imagine; for though the judgment and company of ſuch perſons be not always the beſt grounded, or the beſt choſen, yet their quality or ſtation in the world makes it uſually the moſt conſpicuous, and the moſt conſidered. And I doubt not, there is no ſuch multitude of diſintereſted lovers of good things, but that there will be the fewer found ſtudious to expreſs wit and virtue in converſation, when they ſee, that in the eſtimate of thoſe, that are looked upon as the chief judges of what is or is not good company, the moſt empty and impertinent prattle with confidence, or loudneſs, procures a man at leaſt as good a reception, as the beſt and moſt rational diſcourſe without it. And, which is yet worſe, that tyrannous thing, which we miſ-name civility, has ſo degraded reaſon, as well as diſplaced piety, in converſation, that if there be never ſo many perſons together, entertaining themſelves with rational or inſtructive diſcourſe, in caſe there come in but one impertinent creature, that is below it, all theſe ſhall ſink themſelves to his level, and as much debaſe their diſcourſe, as if they believed it fitter, that all the rational converſers ſhould forego the exerciſe and the benefit of their wit and virtue, than that a fool ſhould not appear to talk as wiſely as any of them. And thus they ſeem aſhamed of their attainments, inſtead of making him aſhamed of his ignorance, and reducing him to improve himſelf into a capacity of being fit for their company; whereas, from a contrary practice, they might derive the great advantage, either of freeing themſelves from uninvited companions, or of making them worth the having.

BUT, (ſubjoins *Lindamor)* I remember I told you there was a ſecond quality, that I diſliked in the nymph I found you entertaining, and that is, that, when I will, I can make her ſpeak to me, juſt what I pleaſe. I know (replies *Eugenius)* that a moderate degree of complaiſance is not only in many caſes allowed us by diſcretion, but neceſſary to keep up the pleaſantneſs, not to ſay the very peace, of human ſocieties; for if all men, at all times, ſpeak their minds freely, and did not ſoften one another by concealing their mutual diſlikes, and diſſents, and by certain outward expreſſions of kindneſs, or reſpect, made by compliments and geſtures, men have ſo many imperfections, and ſo much ſelf-love withal, that ſcarce any two of them would endure one another; nay, and in ſpite of that indulgence, which provident nature has implanted in all animals, for the preſervation of their ſpecies, in that of the individuals that compoſe it, and as much as our own faultineſs has added to that fondneſs; yet, I doubt, we ſhall ſcarce find one man of a thouſand, that would endure ſo much as himſelf, if we did not for the moſt part exerciſe complaiſance within our own breaſts, and did not as much flatter our ſelves, and diſguiſe our ſelves, to our ſelves, as we flatteringly diſguiſe our ſelves to others.

BUT, (continues *Eugenius)* when all this is ſaid, I may endure, but I ſhall ſcarce chuſe and prize a companion, that, like an echo, uſes no liberty of his own, but allows me to direct whatever I would have to be anſwered me: and I know not whether I could not better like one, that would ever diſſent from me, than one that would never do ſo. I cannot look upon him either as my friend, or as a perſon worthy to be made ſo, who never evinces his being more concerned to advantage me, than to pleaſe me, by making uſe of the liberty of a friend, and thereby ſhewing, that he conſiders not barely himſelf, but me: beſides, that as there is no true friendſhip, where there is not an union of affections, ſo methinks there can be no good company, where there is not ſometimes a diſſent in opinions.

EUSEBIUS, that was a friend to ſeriouſneſs, without being an enemy to pleaſantneſs, gathering from the long pauſe made by his friends, that they deſigned not the proſecuting of this diſcourſe any further; Methinks, gentlemen, (ſays he, ſmiling) you are very ſevere to a harmleſs nymph, who is ſo modeſt, and reſerved, that ſhe will never put you upon beginning a conference with her, and ſo complaiſant in it, that it is your own fault, if ever ſhe ſays any thing to you, that diſpleaſes you: and for my part, (continues he) I have that opinion of human things, that as I think there are very few ſo perfect, but that we may find ſomething in them fit to be ſhunned, ſo there are not many ſo imperfect, but that they may ſuggeſt to us ſomewhat or other, that may not be unworthy of our imitation; and as *Lindamor* has taken notice of two qualities in our echo, which diſcommended it to him, ſo I have obſerved as many, that I rather approve than diſlike.

FOR, in the firſt place, it is evident, that our nymph (however *Eugenius* has been pleaſed to miſ-call her a babler) is much leſs talkative than moſt of her own ſex, or indeed of ours; for ſhe never begins to talk with any body, not ſpeaking unleſs ſhe be ſpoken to. He that conſiders how much of the diſcourſe, that waſtes men's time, and entertains the moſt companies with the moſt applauſe, conſiſts of talk, that tends either to flatter thoſe that are preſent, or detract from the abſent, or to cenſure our ſuperiours, or our betters, or to expreſs our own profaneneſs, or to excite the pride or carnality of others; and he that ſhall conſider, that though by theſe and many other ways we are extremely apt to offend in words, yet we muſt give an account for that kind of words, what ſort ſoever be meant by them, which our tranſlators render idle ones;

and that the judge himſelf tells men, that they ſhall by their words, as well as by their actions, be juſtified, or condemned; will eaſily believe, that if ſilence were as much in faſhion, as it is charitable to mankind to wiſh it, the regions of hell would be far thinlier peopled than now they are like to be.

I COULD tell you, that ſilence diſcovers wiſdom, and conceals ignorance; and it is a property, that is ſo much belonging to wiſe men, that even a fool, when he holdeth his peace, may paſs for one of that ſort; and I could eaſily add I know not how much in the commendation of this excellent quality, if I knew how at the ſame time to praiſe ſilence, and to practiſe it: ſo that it may well paſs for an excellency in the nymph, whoſe apology I am making, that ſhe does not ſpeak, but when it is neceſſary ſhe ſhould, I mean, when ſhe is ſpoken to, in ſuch way as does exact her anſwer.

BUT this is not all the good qualities of our echo; for as ſhe rarely ſpeaks, but when it is expected ſhe ſhould, ſo ſhe ſeldom repeats above a ſmall part of what is ſaid to her: this I account a very ſeaſonable piece of diſcretion, eſpecially in ſuch treacherous and fickle times as ours, where, almoſt as if he thought himſelf fit to be an univerſal ſtateſman, ſuch a one concerns himſelf very needleſly for almoſt all the publick quarrels in Chriſtendom, and ſhews himſelf zealous for a party, which will receive no advantage by his diſquiets; and not content like a merchant-venturer, his paſſion may upon this account make him a ſufferer by what happens in the remoteſt parts of the world. In our own fatal differences, (which it is almoſt as unſafe to ſpeak freely of, as it is unhappy to be involved in them) he will on needleſs occaſions declare, with his opinion, his want of judgment, and perhaps ruin himſelf with thoſe, under whoſe protection he lives, by ſpreading reports, and maintaining diſcourſes, that rendered him ſuſpected among thoſe, who think, that a man muſt wiſh their forces ſhould be beaten, if he can think they may have been ſo: nay, I have known ſome, that, though put into conſiderable employments, could not hold talking of their own party, at a rate of freedom, which thoſe that have ſo much innocence as not to deſerve it, will ſcarce have ſo much goodneſs as to ſupport it. So that methinks, theſe men deal with their fortunes as children oftentimes do with their cards, when having taken a great deal of pains to build fine caſtles with them, they themſelves afterwards ruin them with their breath.

IT may be a greater, without being a more prejudicial piece of folly, to believe all that one hears, than to report all that one believes; and eſpecially, thoſe are to be cenſured for want of our nymph's reſervedneſs, by whom it loſes that name: for though thoſe kind of men make ſure, by their way of talking, to make others take notice, how much they are confided in by their own party, yet ſure they would take a diſcreeter courſe, if they did but conſider, that the proof they give, that they are truſted with ſecrets, is, that they are unfit to be ſo.

## DISCOURSE XVIII.

### *Upon a giddineſs occaſioned by looking attentively on a rapid ſtream.*

THESE thoughts of *Euſebius* ſuggeſted ſo many to *Lindamor*, and me, that to entertain our ſelves with them, we walked ſilently a good way along the river ſide; but at length, not hearing any more the noiſe his feet were wont to make in going, turning my ſelf to ſee what was become of him, I perceived him to be a pretty way behind me upon the river's brink, where he ſtood in a fixt poſture, as if he were very intent upon what he was doing. And it was well for him, that my curioſity prompted me to ſee what it was that made him ſo attentive; for, before I could quite come up to him, methought I ſaw him begin to ſtagger, and though that ſight added wings to my feet, yet I could ſcarce come time enough to lay hold on him, and, by pulling him down backwards, reſcue him from falling into the river. The ſhriek I gave at the ſight of my friend's danger, was, it ſeems, loud enough to reach *Euſebius*'s ears; who, turning his eyes towards the place whence the noiſe came, and ſeeing *Lindamor* upon the ground, made haſtily towards us, and came up to us by that time I had helped *Lindamor* up, and before I had received from him the obliging acknowledgments he was pleaſed to make for a piece of ſervice, that I thought had in it more of recompenſe than merit. *Euſebius* hearing what paſſed betwixt us, joined his thanks to *Lindamor*'s, and at the ſame time congratulated my friend for his eſcape, and me for having, to uſe his expreſſions, had the honour and ſatisfaction to be ſuch a perſon as *Lindamor*'s deliverer. But after our expreſſions of joy for his eſcape were over, *Euſebius* and I had both a curioſity to learn particularly the occaſion of his danger, which he told us in theſe words: As I was thinking, *Euſebius*, on your laſt reflection, I was diverted from proſecuting my walk in *Philaretus*'s company, by happening to caſt my eyes on a part of the river, where the ſtream runs far more ſwiftly, than I have all this day taken notice of it to do any where elſe, which induced me to ſtop a while, to obſerve it the more leiſurely: and coming nearer, I found the rapidneſs of the current to be ſuch, notwithſtanding the depth of the water, that I ſtood thinking with my ſelf, how hard it were for one to eſcape, that ſhould be ſo unlucky as to fall into it. But whilſt I was thus muſing, and attentively looking upon the water, to try whether I could diſcover the bottom, it happened to me, as it often does to thoſe that gaze too ſtedfaſtly on ſwift ſtreams, that my head began to grow giddy, and my legs to ſtagger towards the river; into which queſtionleſs I had fell, if *Philaretus* had not ſeaſonably and obligingly prevented it. Something like this (ſays *Euſebius*) does not unfrequently happen in the unwary conſideration of ſome ſorts of ſinful objects, eſpecially thoſe ſuggeſted by atheiſm and luſt: for not only we oftentimes conſider atheiſtical ſuggeſtions, and entertain libidinous fancies, without any intention to quit our ſtation, or the ſecure and ſolid baſis of religion and chaſtity; but we are often inclinable to think, that we converſe with theſe objects only to diſcern their formidableneſs the better, and fortify our reſolutions to ſhun them. And yet ſuch is the pernicious nature of atheiſm, and of luſt, that they turn our brains, and oftentimes, if providence, or Chriſtian prudence, do not ſeaſonably interpoſe, we may unawares fall into the miſchief, even by too attentively ſurveying its greatneſs, and may be ſwallowed up by the danger, even whilſt we were conſidering how great it is. To parly with ſuch faſcinating enemies, though with a deſign to refuſe them, and ſtrengthen our averſion to them, is againſt the laws of our Chriſtian warfare; and though it be not as criminal, may often prove as fatal, as to hold intelligence with the enemy. It is true, that the deformity of both theſe ſins is ſuch, that all their uglineſs cannot be taken notice of at firſt ſight; but the diſcovery is more dangerous than neceſſary, ſince a little knowledge of their hideouſneſs is enough to make every honeſt heart abhor them. And ſince their leſs obvious deformities are more dangerous to be pried into, than neceſſary to be known, let us fear to learn of theſe deluding ſins, more than we need know to hate them; and remember, that even thoſe, that are frighted by ſeeing faces recently marked with the ſmall pox, may, notwithſtanding that fear, catch the diſeaſe with that ſight.

## DISCOURSE XIX.

### *Upon one's drinking water out of the brims of his hat.*

WE were by this time come back to the baited places we had left, when *Eugenius*, to whom his rambling up and down, added to the heat of the day, had given a vehement thirſt, ſpying a place, where the banks were low, and almoſt level with the ſurface of the water, left us for a little while to repair thither; and kneeling upon the ground, he took up with his hat, which by cocking the brims he turned into a kind of cup, ſuch a proportion of water, that he quenched his thirſt with it; and careleſsly throwing the reſt upon the ground, quickly returned towards the company, which he found he had not left ſo ſilently, but that our eyes had been upon him all the while he was abſent: and that ſight afforded *Euſebius* an occaſion to tell us, our friend *Eugenius* might, if he had pleaſed, by ſtooping lower with his head, have drank immediately out of the entire river. But you ſee he thought it more ſafe, and more convenient, to drink out of a rude extemporary cup; and that this way ſufficed him fully to quench his thirſt, we may eaſily gather, by his pouring away of ſome remaining water as ſuperfluous: and if he ſhould tell us, that he could not have quenched his thirſt with a ſufficient quantity of water, becauſe he drank it not out of the river, but out of his hat; I doubt not, you would think him troubled with a more formidable diſtemper than thirſt, and conclude him in a greater need of phyſick than of water.

THUS (reſumes *Euſebius*) to a ſober man, provided he have a competency of eſtate ſuited to his needs and conditions, it matters not very much, whether that competency be afforded him by a moderate or by an exuberant fortune, and oftentimes it is more ſafe and convenient, and no leſs ſatisfactory, to receive this competency out of that, which is but a little, than out of that, which is a great deal more than enough; for not only the neceſſities of nature are few, but her capacities are limited. And therefore, how much ſoever you have of meat, and drink, and the like accommodations; the body of a man can enjoy but a certain, and that too no very great meaſure of them, proportioned to the craving of our ſtinted nature, by more than which it is not the body, but the unruly fancy, that is gratified; as when the ſtomach is ſatisfied, a table full of untouched diſhes feeds but a man's eye, or his pride; and if he ſhould cram a little part of it into his ſtomach, it would be but nauſeated at firſt, and afterwards breed ill humours and diſeaſes. And accordingly, it is no leſs than *Solomon* that ſays, *when goods increaſe, they are increaſed that eat them*; *and what good is there to the owners thereof, ſaving the beholding of them with their eyes?* I dare not abſolutely (purſues he) condemn thoſe, that think not the neceſſities of nature the only meaſures of a competency of fortune: for though he, that wants not them, wants a juſt cauſe to a quarrel with providence, yet cuſtom has ſo entailed ſome ways of expence upon ſome ſtations in the world, that ſince a man can ſcarce live without them, and yet without diſgrace, there are but few who are ſo great Stoicks, or ſuch mortified Chriſtians, as not to think, that what is more than enough for one, may be leſs than enough for another, and as to not eſtimate their having or wanting a competency, not only by the exigencies of nature, but by thoſe of a man's particular quality, or ſtation. But (ſubjoins *Euſebius*) he, that has, in this liberal ſenſe, a ſufficiency of outward goods, is, methinks, but ill adviſed, as well as unthankful, if he repine at his portion, becauſe it is inferiour to thoſe of the famouſly rich: For though an unwieldy affluence may afford ſome empty pleaſure to the imagination, (for to the body it ſcarce affords any at all) yet that ſmall pleaſure is far from being able to countervail the imbittering cares, that attend an overgrown fortune; for whatever the unexperienced may imagine, the frequent and ſad complaints of the rich themſelves ſufficiently manifeſt, that it is but an uneaſy condition, that makes our cares neceſſary for things, that are meerly ſuperfluous; and that men, whoſe poſſeſſions are ſo much ſpread and diſplayed, are but thereby expoſed the fairer and wider marks, that may be hit in many places by misfortune. Nor will careleſſneſs ſecure them, ſince a provident concern of a man's eſtate, though it be great, being by the generality of men looked upon as a duty, and a part of prudence, he cannot ſuffer himſelf to be wronged or cheated of that, without loſing, with his right, his reputation.

For my part, (ſays *Lindamor)* I do the more wonder to ſee men ſo greedy of lading themſelves, as the Scripture ſpeaks, with thick clay, that they hoard up their treaſures from thoſe uſes, which alone make riches worthy the name of goods, and live by a temper quite contrary to that of ſaint *Paul*, *As having all things*, *and poſſeſſing nothing*. When I conſider the things they pretend to by this as mean as unchriſtian appetite; the two chief of theſe are wont to be, the keeping of a great houſe, and the leaving their children great matches. As to the former, though others are too much advantaged by it not to extol it, and though it be ſometimes indeed in ſome caſes a decent, and almoſt neceſſary, piece of greatneſs; yet it is in my opinion one of the moſt unhappy attendants that retain to it; for the laws of hoſpitality, and much more thoſe of cuſtom, turn him, that keeps a great table, into an honourable hoſt, ſubject him to comply with the various and oftentimes unreaſonable humours of a ſucceſſion of gueſts, that he cares not for at all, and that care as little for him; they bring him in a world of acquaintance, to whom he muſt own himſelf obliged, becauſe they come to eat his meat, and muſt really requite them by giving them the pretiouſeſt thing he has to part with, his time: and a full table, together with the liberties that cuſtom allows at it, if not exacts there, tempt him both to indulgence to his appetite, prejudicial to his health, and if they do not prevail with him to ſpeak, do often at leaſt diſpoſe him to hear and to connive at, ſuch free diſcourſes, as are prejudicial to his intereſts. So that there is more than one account, upon which a great entertainer may be involved in *David*'s curſe againſt his mortal enemy, of having his table become a ſnare.

And for the deſign (continues *Lindamor)* of laying up vaſt eſtates for a man's children; if they be ſons, he thereby but increaſes their temptation to wiſh the father dead, and provides incentives to their vice, and fuel for their exceſſes, when he is ſo. And if they be daughters, not to repeat the newly-mentioned inconveniencies; how many unhappy young women have we ſeen, who, upon the ſcore of the vaſt portions left them by their parents, have been betrayed, and ſold by their guardians, or by thoſe relations, that ſhould have been, as they were called, their friends? And how often have we alſo ſeen, that an unwieldy fortune has been ſo far from purchaſing the heir to it a good huſband, that it has procured her a bad one, by making her think her ſelf obliged and qualified to match with ſome high title, and procuring her to be haunted by ſome, whoſe vices perhaps alone have reduced him to ſell himſelf to redeem his fortune, and to make an addreſs which aims but at the portion, not the perſon? And accordingly, when he has got the one, he ſlights the other, and deſpiſes her for the want of that high extraction ſhe prized in him, and perchance hates her too, for confining him from ſome former and more than pretended paſſion.

I perceive then, *Lindamor*, (ſays *Euſebius)* that you are, as well as I, diſpoſed to think him not a meer fool, that prayed God to *give him neither poverty*, *nor riches*, Prov. xxx. 8.

*but to ſupply him with things ſuitable to his condition:* (that ſeeming to be the meaning of the Hebrew phraſe) a pinching poverty, and a luxuriant fortune (though different extremes) being liable to almoſt equal inconveniences, and a competency affording us enough to engage us to thankfulneſs, without adminiſtering ſuch temptations to ſenſuality and pride.

## DISCOURSE XX.

### *On ſeeing boys ſwim with bladders.*

THE ſun was yet ſo near the meridian, that if the attention *Euſebius* diſcourſes excited, had not diverted us from minding the heat of the weather, we ſhould have found it troubleſome; and in effect, ſoon after we had left ſhining to the conferences I have been repeating, we begun to feel a heat, uneaſy enough to oblige us to retire from it; but taking ſeveral ways, as chance or inclination directed us, to ſhun the ſame inconvenience, it was my fortune to hold the ſame courſe with *Lindamor*, and both of us, by following no guide, but the deſign of ſhunning all beaten paths, and unſheltered grounds, that being the likelieſt way to reach our double end of coolneſs and privacy; after we had a while walked ſomewhat near the river-ſide, we were at length brought to a ſhady place, which we ſhould have found, as well as we wiſhed it, a ſolitude, if others had not concurred with us in the ſame hopes: for the expectation of privacy had brought thither divers, whom the ſun's ſcorching heat invited to that cool and retired part of the river, where they hoped to ſhun all other eyes, as well as that of heaven; among thoſe ſwimmers we obſerved ſome novices, who to ſecure their firſt attempts, had bladders tied under their arms, to keep them from ſinking any lower. This ſight (ſays *Lindamor*, after he had a while muſed upon it) hath circumſtances in it, that, methinks, are applicable enough to the education of many of the young ladies of theſe times; of whoſe faults, the excellent *Celia*, and all the others, that you and I can think worth our concern, are free enough to let me entertain you without rudeneſs of them; the commonneſs of theſe blemiſhes, ennobling thoſe few, that are exempted from them. You cannot then (continues *Lindamor*) but have obſerved with me, that many of thoſe young ladies, whoſe parents, out of a miſtaken zeal, condemn that, which at the court was wont to be called good breeding, and principles of honour, as things below a Chriſtian, and inſufficient to bring their poſſeſſors to heaven, are ſo unluckily bred, and ſo ill-humoured, as well as faſhioned, that an almoſt equally unhappy education is requiſite to make their company tolerable. Civility, which is almoſt as eſſential to a compleat lady, as her ſex, they are perfect ſtrangers to, or rude deſpiſers of it; and not only their minds are not imbued with thoſe principles of friendſhip, generoſity, and honour, which make ſome of their ſex ſo lovely, and ſo illuſtrious in ſtory, and of which more ladies would be capable, if more were taught them; but theſe are utterly uninſtructed in the laws of what the French call *Bienſeance*, and are altogether unpractiſed in that civility and ſuppleneſs of humour, which is requiſite to endear converſation, and is ſo proper to the ſofter ſex. I muſt confeſs, (purſues *Lindamor*) that I never have been more puzzled how to behave my ſelf than in their company: the ſerious ſort of diſcourſe (even ſuch as is to be found in our freſher and more poliſhed romances) they are utterly incapable of; and in the trifling and pitiful prattle, that alone is not above them, they are ſo unſociable, ſo indiſcreet, and oftentimes ſo bold, that in ſpite of the reſpect, ſuch as *Celia* gives me for her ſex, I find in their converſations as much exerciſe for my patience as my chaſtity; and being tempted to put off the reſpect that belongs to ladies, as they do their modeſty, I find it more difficult to retain my civility than my liberty. The bladders (reſumes *Lindamor*) which young ſwimmers uſe, are, it is confeſſed, but light and empty things, that are eaſily made uſeleſs; nay, though they help beginners, they are clogs to ſkilful ſwimmers; and yet theſe trifles are they, that hinder novices from ſinking into the mud. Thus honour, though it be an airy unſolid thing, nay, though it oftentimes proves a hinderance to great proficients in Chriſtianity, yet to perſons, that have not yet attained to higher principles, it is an excellent ſupport, and hinders them from ſinking into many meanneſſes and miſcarriages, into which thoſe eſpecially of the fairer ſex, that want a due ſenſe of honour, are too apt to be precipitated: you know what lord told his accuſed lady, that he knew ſhe was too proud to be a whore. And certainly, though principles of gallantry include not all virtues, yet they avert thoſe they ſway from groſſer vices: and though to be well bred be not to be a ſaint, but incomparably inferiour to it, yet to be both, is more deſirable than to be the latter only: and they are very unwiſe, who, before they are ſure their children will admit the higher and more perfect principles of religion, neglect to give them that education, that may render moral accompliſhments acceptable to them, and them to well bred company, leſt by proving indiſpoſed to ſpiritual graces, their not having been taught the moral ornaments of the mind leave them deſtitute of all good qualities.

## THE TRANSITION.

### *Containing a* DISCOURSE *upon the ſport's being interrupted by rainy weather.*

NOTWITHSTANDING the ſerenity and promiſingneſs of the morning we came out in, we have already upon the water had one proof of the unſettledneſs of the weather, and now upon the land we meet with another: for, by that time *Lindamor* was come ſomewhat near the end of this diſcourſe, he was obliged to haſten to it by the approach of a cloud, whoſe largeneſs and blackneſs threatned us with an imminent ſhower; nor did it give us a falſe alarm, for by that time we could recover the next ſhelter, the ſhower we fled from began to fall violently enough upon the trees, we were retired to. And this unwelcome accident reducing us all to look about us, we quickly ſaw, to our grief, that not only the rain but the clouds were increaſed, and the ſky being almoſt every where over-caſt, left us no way to eſcape the inconveniencies it threatned us with, but the making with what haſte we could towards the place, over which we perceived ſmoke enough, to conclude there was ſome village beneath it; and finding at our arrival thither as good an inn, as we could reaſonably expect in ſuch a place, after we had a while dried our ſelves by the fire, *Eugenius* (to whom exerciſe and the time of the day had given a good ſtomach) moved the company, that in ſpite of the meanneſs of the houſe, we might reſt our ſelves there, till we had dreſt the fiſh we had taken, to make up the beſt dinner the place would afford. This motion I did not alone readily aſſent to, but ſeconded it, by repreſenting, that probably by that time we had dined, we ſhould either recover ſome fair weather, or loſe the hopes of regaining it for that day. To which I added other conſiderations, to perſuade the company; though, that indeed, which prevailed with me, was, the expectation of having an opportunity, while dinner was providing, to retire, as I ſoon after did, into another room, and ſet down in ſhort hand what I have hitherto been relating, leſt either delay ſhould make the particulars vaniſh out of my memory, or they ſhould be confounded there by the acceſſion of ſuch new reflections, as, in caſe a fair afternoon ſhould invite us to return to the river, *Euſebius* would probably meet with occaſions of preſenting us. But before I could handſomely ſlink away, I happened to be entertained a while with ſome things of the like nature with thoſe I was about to ſet down: for this unwelcome change, after ſo glorious and hopeful a morning, did naturally ſuggeſt to all of us, ſome thoughts of the mutability and fickleneſs of proſperity, how eaſily, as well as quickly, we may be deprived of that we cannot eaſily part with. But whilſt the reſt of us were entertaining themſelves with theſe thoughts, *Eugenius*, who was more concerned than any other of us, for the ſport he came for, having a good while looked with melancholy eyes upon this change, began to repine and murmur at the interruption, which the perſiſting rain continued to give him in it. Whereupon *Lindamor* took occaſion to ſay, For my part, if I could diſſipate theſe clouds with a wiſh, I ſhould ſcruple at the ridding my ſelf of them, even at ſo eaſy a rate: for I ſee, that the gaping clefts of the parched ground do, as it were with ſo many mouths, proclaim its need of the rain you repine at. And I always (continues he) am ready to join with the huſbandman in his wiſhings, as well for rainy as for fair weather, and am ſo much a commonwealth's man, that I had rather at any time not eſcape a ſhower, than let him want it.

You are I confeſs, (ſays *Eugenius)* now I think a little better on it, in the right, and have more reaſon to be diſcontented at my impatience, than I at the weather: for we ſhould, even in theſe leſſer occaſions, as well as on greater, exerciſe ſelf-denial, and prefer a publick good to our private conveniences: and indeed it were far better, that I ſhould miſs ſome fiſhes, than thouſands of families ſhould miſs of bread.

Eusebius, that had hitherto liſtened to what was ſaid, being unwilling, that his friend's ingenuity ſhould make him any longer accuſe himſelf, told him, (to divert the diſcourſe) This accident, *Eugenius*, was ſuggeſting to me a thought, wherewith I ſhall not ſcruple to acquaint you, and the company. For (continues he) as pleaſant, and as much deſired, as fair weather is wont to be, and as much as we uſe to be diſcontented at a lowering and dropping ſky, yet the one is no leſs neceſſary nor uſeful in its ſeaſon, than the other. For too uninterrupted a courſe of heat, and ſun-ſhine, would make the ſeaſon fruitful in nothing, but in caterpillars, (or ſuch kind of vermin) and in diſeaſes, and is far more proper to fill graves, than barns: whereas ſeaſonable viciſſitudes of clouds, and cloudy weather, make both the ground fruitful, and the ſeaſon healthful. Thus in our outward condition, too long and conſtant a proſperity is wont to make the ſoul barren of all, but ſuch wantonneſſes, as it is ill to be fruitful of, and the interpoſition of ſeaſonable afflictions is as neceſſary, and advantageous, as it can be unwelcome. But (purſues *Euſebius)* the conſideration, that chiefly entertained me, was this, that as here, to make the earth fruitful, the face of heaven muſt be now and then obſcured, and overcaſt, we muſt be deprived of the welcome pleaſure of the ſun to receive the fertilizing benefit of the rain; ſo ſuch is our condition here below, that our perverſeneſs makes it neceſſary, that God ſhould oftentimes appear to frown upon us, to make us fruitful in thoſe works, to which he is pleaſed to vouchſafe his ſmiles. But, oh! (concludes *Euſebius*, lifting up his eyes and hands towards heaven) how happy ſhall we be in that glorious and everlaſting day, when our condition ſhall be as bleſſed in not requiring viciſſitudes as in not being ſubject to them! When the ſun-ſhine alone ſhall perform all that is wont to be done here both by it, and by the rain; and the ſoul, like *Egypt*, being fruitful without the aſſiſtance of the clouds, we ſhall not need to have our joys eclipſed, to have our graces kept from being ſo, or to make our light ſhine the brighter: but each bleſſed ſoul ſhall be emblemed by that viſion in the revelations, where St. *John ſaw an angel ſtanding in the ſun*; we ſhall not then need to have our love weaned from inferiour or undue objects, by any experience of their imperfections; ſince the clear diſcovery, that God will vouchſafe us of his own excellencies, will abundantly ſuffice to confine our affections to them; and ſince the works, wherein we are to be fruitful in heaven, will be but to admire and thank him, that is infinite in beauty and in goodneſs, the perfecter ſight and fruition we ſhall have of his aſtoniſhing as well as raviſhing attributes, will but proportionably increaſe our wonder, and our praiſes, and will naturally make us as grateful for ſuch a ſtate as happy in it.

# OCCASIONAL REFLECTIONS.

## SECTION V.

### REFLECTION I.

*Upon the ſight of* N. N. *making of ſyrup of violets.*

ONE, that did not know the medicinal virtues of violets, and were not acquainted with the charitable intentions of the ſkilful perſon, that is making a ſyrup of them, would think him a very great friend to Epicuriſm: for his employment ſeems wholly deſigned to gratify the ſenſes. The things he deals with are flowers and ſugar, and of them he is ſolicitous to make a compoſition, that may delight more than one or two ſenſes; for in one ſyrup he endeavours to pleaſe the eye, by the lovelineſs of the colour; the noſe, by the perfume of the ſcent; the taſte, by as much ſweetneſs as ſugar can impart. But he that knowing, that violets, though they pleaſe the palate, can purge the body, and notwithſtanding their good ſmell, can expel bad humours, knows alſo, that the preparer of theſe fragrant plants, in making their juice into a ſyrup, is careful to make it acceptable, that its pleaſantneſs might recommend it, and invite even thoſe to prove its virtues, who had rather continue ſick, than make trial of a diſguſting remedy; will not blame his curioſity, but commend his prudent charity; ſince he doubly obliges a patient, that not only preſents him remedies, but preſents him allurements to make uſe of them.

IF I ſee a perſon, that is learned and eloquent, as well as pious, buſied about giving his ſermons, or other devout compoſures, the ornaments and advantages, which learning or wit do naturally confer upon thoſe productions of the tongue, or pen, wherein they are plentifully and judiciouſly employed; I will not be forward to condemn him of a miſ-expence of his time or talents; whether they be laid out upon ſpeculative notions in theology, or upon critical inquiries into obſolete rites, or diſputable etymologies; or upon philoſophical diſquiſitions or experiments; or upon the florid embelliſhments of language; or (in ſhort) upon ſome ſuch other thing, as ſeems extrinſical to the doctrine, that is according to godlineſs, and ſeems not to have any direct tendency to the promoting of piety and the kindling of devotion. For I conſider, that as God hath made man ſubject to ſeveral wants, and hath both given him ſeveral allowable appetites, and endowed him with various faculties and abilities to gratify them; ſo a man's pen may be very warrantably and uſefully employed, though it be not directly ſo, to teach a theological truth, or incite the reader's zeal.

And, beſides what I have been alledging, there is a further, and more principal conſideration, which belongs to this matter. For even wiſe men may proſecute the ſame deſign, without doing it all of them the ſame way; and the ſeveral means and methods they employ, notwithſtanding a great difference in other particulars, may agree in this, that the reſpective chuſers of them had each of them a good aim, and proceeded in a rational way. Though therefore I ſee a man of good parts, ſtudious of learning, or of practiſing, the precepts of eloquence, and ſpend much time in reading florid compoſures, or in making ſuch; I dare not be forward to cenſure him for an effeminate or uſeleſs writer. For there are ſo many things pious or laudable, and ſo many ways, whereby ſome or other of them may either be directly promoted, or indirectly ſerved, by removing objections, or other impediments, that it is not eaſy to be ſure, that a rational man cannot have as well a rational as a well-meant deſign to inſtruct, if not reform, in thoſe very compoſures, that ſeem fitted only to delight. There being a nicer ſort of readers, which need inſtruction (and to whom it is therefore a charity to give it) who are ſo far from being likely to be prevailed on by diſcourſes not tricked up with flowers of rhetorick, that they would ſcarce be drawn ſo much as to caſt their eyes on them.

A while before *Eſther* made that generous attempt, wherein, to reſcue the people of God, ſhe hazarded a throne, to which above an hundred other peoples paid homage, and ventured at once the greateſt crown and the faireſt head in the world; one, that had ſeen only what ſhe was doing, without knowing why ſhe did it, would perchance have thought her employed, more like a diſciple of *Epicurus* than of *Moſes*, whoſe people and her own was then in a forlorn and gaſping condition. For the Scripture telling us, that *ſhe put on her royal apparel*, and the tenour of the ſtory intimating with what aim ſhe did it, we may well ſuppoſe, that ſhe was not ſparing in jewels and other of the richeſt ornaments, on an occaſion, where her quality exacted, that ſhe ſhould appear with a magnificence befitting the greateſt princeſs in the world; and that ſhe was very curious in a dreſs, that was to heighten her beauty, when by that, with the giver's aſſiſtance, ſhe was upon her knees, to dazzle the world's greateſt monarch on his throne, and make him pay homage to her charms, to whom above an hundred nations had preſented their faireſt productions, (the brighteſt nymphs of the Eaſt). And thoſe, that have read any thing of the Aſiatick luxury, will eaſily believe our pious queen to have been alſo very ſollicitous about the choice and ordering of her ſweetmeats, when ſhe was to treat an Aſian monarch, who had treated the whole people of the chief city of the world for many days together, and as many princes, as made up the nobleſt part of mankind, for above twenty times as long: and yet this magnificent queen, that ſeemed buſied about none but ſenſual imployments, had ſo commendable a deſign both in her ornaments, and in her banquets, that ſo meritorious an imployment of her greatneſs ſhewed her to be worthy of it; and, as it appeared in the event, that her banquets did co-operate with her faſts, and her royal robes with *Mordecai*'s ſack-cloth and aſhes, to that happy reſcue of her nation, for which, after ſo many ages, it doth to this day yearly celebrate her memory: ſo whilſt ſhe ſeemed buſied to gratify others ſenſuality and her own pride, her diſpoſition of mind was ſo worthy the ſucceſs, that crowned her attempt, that at the ſame time ſhe was providing all that pomp and thoſe delicacies, ſhe was alſo providing to give them, and ſacrifice them, for the intereſt of God's church, and her people; generouſly venturing for the ſervice of heaven a height of proſperity, for whoſe loſs nothing but heaven itſelf could make her amends.

## REFLECTION II.

### *Upon the ſight of a paper-kite in a windy day.*

EUGENIUS, LINDAMOR.

EUG. IF the air were calm and quiet, this kite would lie unregarded even by thoſe very youths, that now look at nothing elſe. But the wind, that blows away ſtraws and feathers, and throws down leaves, does even by its being contrary, help to raiſe this paper-engine to that admired height, which makes it be gazed at by many others, than boys, and not only attract our eyes, but ſometimes ſoar out of their reach. Thus, if a great perſon, for courage, or parts, or both, have the ill fate to live in quiet, and peaceful times, he may long enough languiſh unregarded in an age that needs him not. But if the times grow troubleſome and dangerous, his generous ſpirit will not only ſurmount the difficulties, that are wont to attend them, but be raiſed by them, and turn them into ſteps to glory and preferment.

LIND. Methinks, *Eugenius*, theſe kites may afford us no leſs fit a reſemblance of the fate of ſome errors about religion, eſpecially if they chance to be maintained by men, that are reſolute, and viceleſs. For there are ſome of theſe conceits ſo fond, and groundleſs, that they could not long ſubſiſt of themſelves, and would ſoon ceaſe to tempt a ſolemn oppoſition, if they did not too ſoon meet with it. And as you were obſerving to another purpoſe, that theſe artificial kites, which men take no notice of in calm weather, are both elevated and kept aloft by the blaſts of contrary winds; ſo theſe erroneous opinions I ſpeak of, would, if they were let alone, grow quickly unregarded, whereas needleſs or ill-managed perſecutions of doctrine, not prejudicial to government, (for it is only ſuch, that I mean) bring them into every body's eye, and give them a repute, that nothing elſe would have procured them, and make them be looked upon as things of a ſublime and celeſtial nature, that lead to that heaven, they ſeem to aſpire to. To thrive by perſecution, though it be a great advantage, yet it is not the incommunicable prerogative of divine truths; and though it be certain that they get moſt by it, yet even errors do often gain by it too, there being certain advantages, that accrue to opinions, by being perſecuted, without diſtinguiſhing, whether they be true, or falſe. For men, that are perſecuted for their religion, are generally careful to inſtruct themſelves thoroughly in it, and furniſh themſelves with arguments to defend it. The frowns of the magiſtrate, and the watchful eyes of their adverſaries, are ſtrong diſſuaſives to them from doing any thing, that may arm his hand, or provoke other's tongues againſt their ſect, to which they know their perſonal faults will be imputed. And above all this, their ſufferings intitle them to popular commiſeration, which is a thing, that diſtreſs does ſo much invite, that even condemned malefactors ſeldom want a ſhare in it. And to ſome of theſe men perſecution is the more favourable, becauſe it puts them upon fighting with the weapons they can beſt handle. For ſome are far better at ſuffering, than at diſputing, and can more eaſily indure a priſon, than anſwer a ſyllogiſm. And as this conſtancy is often their beſt argument, ſo is it an argument, that the generality of men beſt underſtand, and conſequently is likely to be moſt wrought on by; ſo that the more harſh than effectual way, wherein they are dealt with, gives them the opportunity to diſplay a reſoluteneſs, that makes moſt men think them well meaning, and in earneſt, and their own party cry them up for martyrs, or at leaſt confeſſors; which, in caſe that (as it happens in moſt ſtates) ſcandalous ſins be left unpuniſhed at the ſame time, that harmleſs errors are ſo ſeverely dealt with, gives them the fairer opportunity to inſinuate into the minds of the people, that their perſecutors had rather ſee men vicious, than inquiſitive. And, generally ſpeaking, any perſonal ſufferings, that a well-meaning man undergoes for what he judges his conſcience, is but ſuch a kind of burden to his mind, as feathers are to an eagle, or a falcon, which, though in themſelves conſidered they have a weight, yet inſtead of clogging him, they not only help him to ſupport himſelf, but enable him to ſoar towards heaven, and reach a height, that makes him praiſed or wondered at.

## REFLECTION III.

*Killing a crow (out of a window) in a hog's trough, and immediately tracing the enſuing reflection with a pen made of one of his quills.*

LONG and patiently did I wait for this unlucky crow, wallowing in the ſluttiſh trough, (whoſe ſides kept him a great while out of the reach of my gun) and gorging himſelf with no leſs greedineſs, than the very ſwiniſh proprietaries of the feaſt, till at length having guzzled and croaked enough, when by hovering over his beloved dainties, he had raiſed himſelf high enough, to prompt me to fire at him, my no leſs unexpected, than fatal ſhot, in a moment ſtruck him down, and turning the ſcene of his delight into that of his pangs, made him abruptly alter his note, and change his triumphant chant for a diſmal and tragick noiſe. This method is not unuſual to divine juſtice towards brawny and incorrigible ſinners, whoſe ſouls no leſs black, than this inauſpicious bird's feathers, do wear already the livery of the prince of darkneſs, and with greedineſs do the works of it, whoſe delights are furniſhed (as the feaſts of crows are by carrion) by their own filthy luſts, or other people's faults, and who by the oaths and curſes, wherewith they offend Chriſtian ears whilſt they live, and by the ill odour they leave behind them when they are dead, do but too much juſtify my reſembling them to theſe hateful creatures. Such ſenſual and obdurate Epicures, I ſay, God oft times ſuffers to run on their long career, in paths of their own chuſing, without checking them in the fruition of thoſe joys, which are to
Gen. xv. 16. be their only portion, till at length *their iniquity filling up the determinate meaſure*, he cuts them off, in the height of their enjoyments, and employing oft-times their own ſins for their executioners, or at leaſt inſtruments of their deſtruction, precipitates them headlong from the pinacle of their delights, into the bottomleſs pit, which one of their predeceſſors (the rich man in the parable) called, as he ſadly found it, the
Luke xvi. 28. *place of torment*, where the luſcious ſweets of ſin are ſo dearly reckoned for, and afford
2 Sam. ii. 26. ſo much *bitterneſs in the latter end*, that their ſenſe ſadly convinces them, of (what their ſenſuality kept them from believing) the folly of gaining any thing at the rate of loſing their own ſouls. Thus the Iſraelitiſh prince found a Nemeſis bold enough to violate the ſanctuary, even of his miſtreſs's arms, and (regardleſs of its charms) enter that lovely circle, their kindneſs cloſed him in, to ſnatch him thence, and extinguiſh
Num. xxv. the luſtful flames, that lighted him thither, with the cold blaſts of death. Thus the mutinous loathers of manna, and luſters after fleſh, had their wiſh ſeverely granted, for they had indeed quails ſerved in by fields-full, but attended with ſo ſudden and
Num. xi. 33. ſharp a reckoning, that *whilſt the fleſh was yet between their teeth, ere it was chewed*, death hindered them to ſwallow it, choaked them with it, and devoured them as greedily, as they did thoſe birds. Thus the inſolent Philiſtines found themſelves ill
Judges xvi. protected by their vainly celebrated God, and his (much ſtronger) temple, though in the latter there were thouſands of them, without any other enemy, than one, they

had ſent for to be a friend to their mirth. For in the very midſt of all the triumphs of a ſolemn feſtival (which had more properly been kept to *Dalilah*) whilſt they were inſulting over captive *Sampſon*'s blindneſs, they could not ſee their own approaching deſtiny, though it were then ſo near, that the next fit of laughter had not time to paſs to their mouths, ere an unexpected vengeance (the provoked Deity lending an omnipotent arm to *Sampſon*'s hand) confounded in one ruin, the idol with the worſhippers, and ſuddenly turned the whole temple into an altar, with which the prieſts themſelves fell ſurprized ſacrifices to that tragical ſolemnity. And thus (to haſten from ſo ſad a theme) the revelling *Belſhazzar*, in the midſt of his magnificent and royal feaſt, ſaw an intruding hand, which by its manner of appearing, as well as by what it wrote, was able to mar the ſupper, without impairing the dainties. And that monarch, whom even a ſiege could not reduce below a condition of feaſting, though he were carouzing in the conſecrated cups, had ſuch a brimmer of trembling put into his hand, as both preſaged, and perchance, began the deſtiny approaching him under the enſigns of the noble *Cyrus*, whoſe conquering ſword, guided by providence, and made the ſword of juſtice, did that very ſame night let out his wine, and blood, and life together.

### *Upon the ſame ſubject.*

IT is hard on ſuch an occaſion to avoid making ſome reflection upon the mutability of worldly conditions! How little did this crow imagine, a quarter of an hour ſince, that in ſo ſhort a time, his body ſhould be as ſenſeleſs, and as ſtinking carrion, as that he was wont to feed it with; that his feathers ſhould wear ſo unlucky a kind of mourning for his deſtruction, and that I ſhould write his epitaph with one of his own quills! Sure, ſince a few minutes can turn the healthieſt bodies into breathleſs carcaſes, and put thoſe very things into the hands of our enemies, which were they, that we principally relied on for our ſafety, it were little leſs than madneſs, to repoſe a diſtruſtleſs truſt in theſe tranſitory poſſeſſions, or treacherous advantages, which we enjoy but by ſo fickle a tenure. No; we muſt never venture to wander far from God, upon the preſumption, that death is far enough from us; but rather in the very height of our jollities, we ſhould endeavour to remember, that they, who feaſt themſelves to-day, may themſelves prove feaſts for the worms to-morrow.

## REFLECTION IV.

### *Upon a glow-worm, that he kept included in a cryſtal phial.*

At Lees,

IF this unhappy worm had been as deſpicable as the other reptiles, that crept up and down the hedge, whence I took him, he might, as well as they, have been left there ſtill; and his own obſcurity, as well as that of the night, had preſerved him from the confinement he now ſuffers. And if, as he ſometimes for a pretty while withdrew that luminous liquor, that is as it were the candle to this dark lanthorn, he had continued to forbear the diſcloſing of it, he might have deluded my ſearch, and eſcaped his preſent confinement.

RARE qualities may ſometimes be prerogatives, without being advantages. And though a needleſs oſtentation of one's excellencies may be more glorious, yet a modeſt concealment of them is uſually more ſafe: and an unſeaſonable diſcloſure of flaſhes of wit, may ſometimes do a man no other ſervice, than to direct his adverſaries, how they may do him a miſchief.

AND as though this worm be lodged in a cryſtalline priſon, through which it has the honour to be gazed at by many eyes, and, among them, by ſome, that are ſaid to ſhine far more in the day than this creature does in the night; yet no doubt, if he could expreſs a ſenſe of the condition he is in, he would bewail it, and think himſelf unhappy in an excellency, which procures him at once admiration and captivity, by the former of which he does but give others a pleaſure, while in the latter he himſelf reſents a miſery.

This oftentimes is the fate of a great wit, whom the advantage he has of ordinary men in knowledge, the light of the mind expoſes to ſo many effects of other men's importunate curioſity, as to turn his prerogative into a trouble: the light, that ennobles him, tempts inquiſitive men to keep him, as upon the ſcore we do this glow-worm, from ſleeping: and his conſpicuouſneſs is not more a friend to his fame, than an enemy to his quiet; for men allow ſuch much praiſe, but little reſt. They attract the eyes of others, but are not ſuffered to ſhut their own; and find, that by a very diſadvantageous bargain, they are reduced for that imaginary good, called fame, to pay that real bleſſing, liberty.

And, as though this luminous creature be himſelf impriſoned in ſo cloſe a body as glaſs, yet the light, that ennobles him, is not thereby reſtrained from diffuſing it ſelf: ſo there are certain truths, that have in them ſo much of native light or evidence, that by the perſonal diſtreſſes of the propoſer, it cannot be hidden, or reſtrained; but in ſpite of priſons, it ſhines freely, and procures the teachers of it admiration, even when it cannot procure them liberty.

## REFLECTION V.

*Upon a court's being put into mourning.*

## PART I*.

Hague 1648.

GENORIO, EUSEBIUS, LINDAMOR.

Genor. METHINKS, you look, *Euſebius*, as if the change, that blacks have made in this place, ſince I laſt ſaw you here, tempts you to queſtion, whether or no this be the court.

Lind. Yet, I fear, *Euſebius* will ſcarce doubt, that you, and theſe other gentlemen are courtiers, whilſt he ſees, how much you diſſemble in perſonating ſadneſs: for though your clothes look mournful, your faces do not, and you talk to one another as unconcernedly, as when you wore lighter colours; and your grief is ſo ſlight, that it has not an influence ſo much as upon your looks, and words, which yet are things, that courtiers are ſaid to be able to diſguiſe without an over-difficult conſtraint.

Genor. But, I hope, *Lindamor*, I need not labour to perſuade ſuch as you, that, when we ſeem to mourn, without doing it, we may be thought guilty of diſſimulation, without being ſo: for what duty is there, that you and I ſhould be really troubled for the death of a prince, whoſe ſubjects we were not, who never obliged us, and who perhaps did only keep the power of doing good, which himſelf never uſed, from a ſucceſſor, that had the will to employ it? But you will demand, why then we put on black; to which the anſwer is eaſy, that cuſtom having eſtabliſhed that ceremony in the courts of princes, in amity with each other, the omiſſion would be looked upon as an affront, and be a provocation. And therefore, the blacks we wear, are not meant to expreſs a grief for the dead, but a reſpect to their living relations: and thus, this as heartleſs as ſolemn ſhew of mourning is not put on by hypocriſy, but by prudence, or civility. And in this caſe, I would appeal to *Euſebius* himſelf, but that I perceive ſome object or other has, ever ſince we began to talk, engroſſed his attention, as well as ſealed up his lips.

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* For there was a ſecond part of this reflection, but when it was to be ſent to the preſs it could not be found, nor would the preſs's haſte, and the author's occaſions, allow him either to ſtay till it were found, or write a new one.

LIND. I have taken notice of it, as well as you, *Genorio*, and I confeſs, I would give much to learn his thoughts.

EUSEB. It is odds then, *Lindamor*, that you would over-purchaſe ſo worthleſs a knowledge: and to ſatisfy your curioſity at an eaſier rate, I will tell you, that I was obſerving, how a gentleman, who, it ſeems, does not much frequent the court, chancing to come in a coloured ſuit, that, but laſt week, would have been thought a fine one, was ſtared at by all in the room except your ſelves, whoſe faces chanced to be turned from him, like a man of another country, (not to ſay of another world) which the poor gentleman at length perceiving, he ſoon grew ſo ſenſible of it, that in ſpite of the richneſs and newneſs of his clothes, with many bluſhes he ſlunk out of the court, to which he found men's gazing at him concluded him to be a ſtranger.

LIND. But this, *Euſebius*, is only to tell us, what you obſerved, not what reflections you made upon it; and you know, that which I was inquiſitive after, was your thoughts.

EUSEB. I will add then, *Lindamor*, ſince you will have it ſo, that I was conſidering, that there has been no law made by the ſtate to forbid any, much leſs ſtrangers, to appear in this court in coloured clothes: and thoſe, which the gentleman I was ſpeaking of, had on, were ſuch, both for fineneſs, and faſhionableneſs, as would very well become a greater court, if it were not in mourning. But, now the prince, and thoſe, that have the honour to belong to him, or to frequent this place, have put themſelves into blacks, to appear in another, though in a finer habit, is, to betray one's not belonging to the court, nor uſing to come to it; and among ſo many, that think they have a right to give laws in point of clothes, a laced, or an imbroidered ſuit, though laſt week in requeſt, would, now they have laid them by, make a man look not ſo much like a courtier, as a player. And this reflection invited me to conſider further, what a ſtrange influence faſhions have on mankind, and what an happy change might be eaſily made in the world, if they, who have it in their power to introduce cuſtoms, would make it their endeavour to introduce good ones.

LIND. I am ſo much of your mind, *Euſebius*, that I confeſs, I envy not princes ſo much for the ſplendour and the pleaſures that they live in, nor for the authority of raiſing armies, nor, perchance, for the happineſs of making them victorious, as for the power of impoſing and reforming of faſhions. And I think it a leſs improveable prerogative, to be able to coin any metal into money, or call it in at pleaſure, than by the ſtamp of their authority to introduce good cuſtoms, and make them current.

GENOR. But, do not princes enough, when they take care to make good laws, and ſee them well executed?

LIND. I will not diſpute, whether by that, they do all they ought, but ſure I am, they do not all they may: for human laws being made for the civil peace of human ſocieties, they are wont to be framed not for the making men virtuous, but the reſtraining them from being miſchievous; they conſiſt far more of prohibitions than commands, and even their prohibitions reach but to a little part of what is ill; the buſineſs of laws being to provide, not againſt all evils, but thoſe groſſer ones, that are prejudicial to civil ſocieties: ſo that there are a thouſand rules of reaſon, or Chriſtianity, which ſtates have not thought fit to turn into laws. For pride, envy, covetouſneſs, gluttony, intemperance, effeminateneſs, oaths, idleneſs, and I know not how many other ſins, contrary to the laws of nature, and of Chriſt, are ſo little provided againſt by human ſanctions, that one may be a bad Chriſtian, and a bad man, without being a bad citizen; there being nothing more eaſy, nor, I fear, more uſual, than for multitudes to paſs uncited before man's tribunal, to receive their condemnation at God's. But though a prince can ſcarce, as a legiſlator, prevent, or ſuppreſs ſuch ſins, yet, as a pattern, he may do much towards it: for by his example, his opinions, his encouragements, and his frowns, he may reform an hundred particular things, which the laws do not (and perhaps cannot) reach. His declared eſteem of ſuch and ſuch practices, joined with his particular actions ſuited to it, and his profeſt diſlike of thoſe ſinful or diſhonourable courſes, he finds the rifeſt, backed with a ſteady and reſolute diſcountenance of thoſe, that do not decline them, will, in a ſhort time, bring thoſe, that are about him, to conform their actions and behaviour to what men are ſatisfied, he deſires, or likes. And thoſe, whom their nearneſs to him, or their employments, make the conſpicuous and exemplary perſons, being thus modeled, their relations and dependants will quickly be ſo too; and then that which is in requeſt at court, being upon that very account looked upon as the faſhion, it will by degrees be imitated by all thoſe, on whom the court has influence; ſince, as we juſt now ſaw in the inſtance of *Euſebius*'s gaudy gentleman, men will be aſhamed to be unlike thoſe, whoſe cuſtoms and deportments paſs for the ſtandards, by which thoſe of other men are to be meaſured.

## REFLECTION VI.

### *Upon hearing of a lute firſt tuned, and then excellently played on.*

THE jarring ſtrings made ſo unpleaſant a noiſe, whilſt the inſtrument was tuning, that I wonder not at the ſtory, that goes of a Grand Signior, who being invited by a Chriſtian embaſſador to hear ſome of our muſick, commanded the fidlers to be thruſt out of his ſeraglio, upon a miſ-apprehenſion, that they were playing, when they were but tuning. But this rare artiſt had no ſooner put an end to the ſhort exerciſe he gave our patience, than he put us to the exerciſe of another virtue; for his nimble and ſkilful fingers make one of the innocenteſt pleaſures of the ſenſes to be one of the greateſt, and this charming melody (for which *Orpheus* or *Orion* themſelves might envy him) does not ſo properly delight as raviſh us, and render it difficult to moderate the tranſports of our paſſions, but impoſſible to reſtrain the praiſes, that expreſs our ſatisfaction: ſo that if this muſician had been diſcouraged by the unpleaſant ſounds, that were not to be avoided, whilſt he was putting his lute in tune, from proceeding in his work, he had been very much wanting to himſelf, and to ſave a little pains, had loſt a great deal of pleaſure and applauſe.

Thus, when the faculties and paſſions of the mind, either through a native unrulineſs, or the remiſſneſs of reaſon and conſcience, are diſcompoſed, he, that attempts to bring them into order, muſt expect to meet at firſt but an uneaſy taſk, and find the beginning of a reformation more troubleſome, for the time, than the paſt diſorders were: but he is very little his own friend, if he ſuffers theſe ſhort-lived difficulties to make him leave his endeavours unproſecuted; for when once they have reduced the untuned faculties and affections of the ſoul to that paſs, which reaſon and religion would have them brought to, the tuned or compoſed mind affords a ſatisfaction, whoſe greatneſs does even at preſent abundantly recompence the trouble of procuring it, and which is yet but a prelude to that more raviſhing melody, wherein the ſoul (already harmonious within itſelf) ſhall hereafter bear a part, where the harps of the ſaints accompany the glad voices, that ſing the ſong of the lamb, and the allelujahs of the reſt of the celeſtial choir.

## REFLECTION VII.

*Upon being preſented with a rare noſegay by a gardener.*

LINDAMOR, EUSEBIUS.

LIND. HERE is indeed a preſent, for which I muſt ſtill think myſelf this fellow's debtor, though he thinks I have overpaid him. It is pity theſe rarities were not more ſuitably addreſſed, and worn by ſome of nature's other maſter-pieces, with whom they might exchange a graceful luſtre, and have the ornament they confer reflected back upon them. But one, that had never been a lover, would perhaps ſay, that that wiſh were more civil to the flowers, than the ladies, of whom there are few, which theſe ſoft poliſhed ſkins, and orient tinctures, would not eaſilier make foils, than prove ſuch to them: for (not to name the reſt) this lovely fragrant roſe here wears a bluſh, that needs not do ſo, at any colour the ſpring itſelf can, amongſt all her charming rarities, ſhew. Yes, here are flowers above the flattery of thoſe of rhetorick; and beſides, two or three unmingled liveries, whoſe ſingle colours are bright, and taking enough to exclude the wiſh of a diverſity, here is a variety of flowers, whoſe dyes are ſo dexterouſly blended, and fitly chequered, that every ſingle flower is a variety. I envy not *Arabia*'s odours, whilſt that of this freſh bluſher charms my ſenſe, and find my noſe and eyes ſo raviſhingly entertained here, that the bee extracts leſs ſweetneſs out of flowers; which were they but leſs frail, I fear would make me more ſo than yet I am. Surely this gardener leads a happy life! He inherits nothing of *Adam*, but that primitive profeſſion, that imployed and recompenced his innocence, and ſuch a gay and privileged plot of his *Eden*, as ſeems exempted from the general curſe, and inſtead of the thorns and thiſtles, that are the unthankful earth's wonted productions, brings him forth lillies and tulips, and gratefully crowns his culture (for toil I cannot think it) with chaplets of flowers.

EUSEB. I perceive, (*Lindamor*) that you judge of the delightfulneſs of this man's calling, only by theſe lovely and fragrant productions of it. And you ſee theſe curious flowers in their prime, without ſeeing by what practices, and degrees, they have been brought from deſpicable ſeeds to this perfection and luſtre. And perhaps, if you conſidered, that a gardener muſt be digging in the violent heats of the ſummer, and muſt be afraid of the bitter cold of the winter, and muſt be watchful againſt ſurpriſing froſts in the ſpring, and muſt not only prune, and water, and weed his ground, but muſt, to obtain theſe gaudy and odoriferous flowers, ſubmit to deal with homely and ſtinking dung: if (*Lindamor*) you would take notice of theſe and of ſome other toils, and hardſhips, that attend a gardener's trade, you would (I doubt not) confeſs, that his imployments, like his buſhes, bring him thorns as well as roſes.

AND now give me leave (*Lindamor*) to tell you, that this may be applied to the condition of ſome ſtudious perſons, that you and I know. For when we hear a learned or eloquent ſermon, or read ſome book of devotion, or perhaps ſome occaſional diſcourſe handſomely written, we are apt to envy the preacher or the writer, for being able to ſay ſome things, that inſtruct or pleaſe us ſo much. But alas, (*Lindamor*) though we ſee not theſe productions of the brain till they are finiſhed, and conſequently fitted to appear with their full advantages abroad; yet to bring them to that paſs, the author may perhaps undergo many a trouble, that we dream not of. For he, that has to do with difficult or weighty ſubjects, cannot preſent us a good book, or a fine diſcourſe, with the ſame eaſe, that a rich man can preſent us a fine pair of gloves, or a fine collation, which may be had at an hour's warning from the next milliner's or confectioner's. For to be able to write one good book on ſome ſubjects, a man muſt have been at the trouble to read an hundred: to grow capable to give a better rendering of a Greek text, he muſt, perchance, have peruſed *Suidas*, *Stephanus*, *Heſychius*, and I know not how many lexicographers and ſcholiaſts: to be qualified to make a tranſlation of an Hebrew word or phraſe, that ſhall illuſtrate a dark text, or clear a difficulty, or more fitly agree with his notion, or accommodation of a place in Scripture, a man muſt have not only, like a ſchool-boy, learned an Hebrew grammar, and turned over *Buxtorf*'s, *Schindler*'s, and other dictionaries, but (which is worſe) he muſt, in many caſes, hazard his eyes and his patience in converſing with ſuch Jewiſh writings, not only as *Elias* his *Tiſhbi*, and *Kimchi*'s *Michlol*; but to gain a little rabbinical learning, and find out ſome unobvious ſignification of a word or phraſe, he muſt devour the tedious and voluminous rhapſodies, that make up the Talmud, in many of which he can ſcarce learn any thing, but the art of ſaying nothing in a multitude of words; and in others, which are not ſo uſeleſs, the moſt he will find in I know not how many dull pages, (written with as little wit as truth) will perhaps be an account of ſome wild opinion, or ſome obſolete cuſtom, or ſome ſuperſtitious rite of a generation of people, whoſe fancies and manners ſcarce any thing makes worth our inquiring after, but their having lived many ages ſince. And even when a man ſets himſelf to write thoſe ſmooth compoſures, where eloquence is conſpicuous, and ſeems to be chiefly deſigned, the author ſeldom comes by his contentment on as eaſy terms as the readers come by theirs. For, not to mention, that ſometimes periods, that in a well-printed book look very handſomely, and run very evenly, were not in the written copy without interlining and tranſcriptions; thoſe, that are ſcholars themſelves, can hardly write without having an ambition, or at leaſt a care, to approve their diſcourſes to them that are ſo too. And in the judgment of ſuch peruſers, to be able to write well, one muſt not only have ſkill in the ſubject, but be well ſkilled in the way of writing, leſt the matter be blemiſhed by the manner of handling it. And although to ſhew one's ſelf a maſter, in treating of variety of themes with a florid ſtyle, and even in thoſe compoſures, that are deſigned chiefly to expreſs wit and move affections, one may think, that nature may be well let alone to ſupply any ſhe has been kind to, with all they need, yet even in theſe caſes there are ſome toils and uneaſineſſes, that are ſcarce to be avoided; ſince a diſcreet man, though never ſo rich in nature's gifts, will think himſelf obliged to ſtudy rhetorick, that he may be ſure he does not tranſgreſs the laws of it. For though an author's natural parts may make his book abound with wit, yet without the help of art he will ſcarce make it free from faults. And to be well ſtocked with compariſons, which, when ſkilfully managed, make the moſt taking paſſages of fine pieces, one muſt ſometimes ſurvey and range through the works of nature and art, which are the chief warehouſes, where variety and choice of ſimilitudes is to be had; and to obtain thoſe pleaſing ornaments, there is oftentimes required no leſs pains than to deviſe uſeful notions. As one muſt ſearch the ditches among briars and weeds, not only to find medicinable herbs, but to gather primroſes and violets. So that (*Lindamor*) to conclude, if we conſider the trouble, that applauded compoſures do oftentimes coſt their authors, we ſhould be ſenſible we owe more, than moſt men think we do, to thoſe, to whom we owe good books. But then unleſs they find ſome recompence for their labours, in the ſatisfaction of promoting piety, or in the well-natured pleaſure they feel themſelves in pleaſing others, I ſhould ſcarce doubt, but that ſome of the writers, we think ſo happy, may rather deſerve our eſteem than our envy.

## REFLECTION VIII.

### *Upon a child that cried for the ſtars.*

I REMEMBER *P. S.* did once, upon juſt the like theme, diſcourſe to the following purpoſe.

AMONGST thoſe numerous eyes, that theſe fair lights attract in ſo clear a night as this, there are not perhaps any, that are more delighted with them, than this child's ſeem to be. And thoſe Perſians, that adored the riſing ſun, could not be more charmed with that glorious object, than this child is with theſe twinkling lights, that need his abſence to become ſo much as viſible. But his is a pleaſure, that is not more great than unquiet, for it makes him querulous, and unruly; and becauſe he cannot by his ſtruggling, and reaching forth his little hands, get poſſeſſion of theſe ſhining ſpangles*, that look ſo finely, their fires produce water in his eyes, and cries in his mouth, that are very little of kin to the muſick the Platoniſts fancied in the ſpheres he looks at. Whereas, though my inclinations for aſtronomy make me ſo diligent a gazer on the ſtars, that in ſpite of my great obnoxiouſneſs to the inclemency of the nocturnal air, I gladly ſpend the coldeſt hours of the night in contemplating them; I can yet look upon theſe bright ornaments of heaven it ſelf, with a mind as calm and ſerene, as thoſe very nights, that are fitteſt to obſerve them in.

I KNOW divers men, for whom nature ſeems to have cut out too much work, in giving them, in an unconfinedly amorous diſpoſition of mind, ſtrong appetites for almoſt all the fair objects, that preſent themſelves to their ſight; theſe amorous perſons may be, I grant, very much delighted, when they firſt gaze upon a conſtellation of fair ladies; but the heart commonly pays dear for the pleaſure of the eye, and the eager deſires, that beauty creates, are in ſuch men excited too often not to be frequently diſappointed, and are wont to be accompanied with ſo many jealouſies, and fears, and repulſes, and difficulties, and dangers, and remorſes, and deſpairs, that the unhappy lovers (if thoſe, that love more than one, can merit that title) do rather languiſh than live, if you will believe either their own querulous words, or their pale and melancholy looks, which would make one think they were juſt entering into the grave, or had been newly digged out of it. Whereas a perſon, that has his affections and ſenſes, at that command, which reaſon and religion require and confer, can look upon the ſame objects with pleaſed but not with dazzled eyes: he conſiders theſe bright and curious productions, as fair animated ſtatues of nature's framing, and contenting himſelf to admire the workmanſhip, adores only the divine artificer, whoſe infinite amiableneſs is but faintly ſhadowed forth even by ſuch lovely creatures. And therefore what has been ſaid of miſtreſſes, may be more juſtly applicable to all the other objects of men's too eager paſſions. To be ſhort, looking upon theſe art of nature, with a philoſopher's and a Chriſtian's eyes, he can caſt them on thoſe bright objects with pleaſure, and yet withdraw them without trouble, and allowing beauty to contribute to his delight, without being able to create him any diſquiet; though it afford him a leſs tranſporting pleaſure than it ſometimes does the amoriſt, yet, all things conſidered, it may afford him a greater pleaſure, by being more innocent, more untroubled, and more laſting; and there may be ſuch a difference betwixt the contentment of this calm admirer of beauty, and that of a greedy and unconfined proſtitutor of his heart to it, as there is betwixt the unquiet pleaſure, that the ſight of the ſtars gives to this child, and the rational contentment it may afford to an aſtronomer.

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* Thus in a ſtarry night fond children cry
For the rich ſpangles, that adorn the ſky. Mr. *W.*

## REFLECTION IX.

### *Upon my lady* D. R. *her fine cloſet.*

LINDAMOR, EUSEBIUS.

A. D. 1651.

LIND. IS not this cloſet ſtrangely fine, *Euſebius?* Here is ſuch a variety of pretty and taking objects, that they do as well diſtract the eye as delight it; the abundance, the choice, and the order, do as well diſcloſe the fair poſſeſſor's ſkill, as her magnificence, and ſhew at once, that ſhe both has plenty, and deſerves it, by knowing ſo well how to make uſe of it. Thoſe things, that are here ſolitary, or ſingle, will ſcarce be elſewhere matched; and all the reſt are ſo pretty, and ſo excellent in their ſeveral kinds, that the number of fine things, that make up this curious collection, cannot hinder any of them from being a rarity. And in a word, the embelliſhments, that adorn and ennoble this delightful place, are ſuch, that I believe the poſſeſſor of them, as welcome as ſhe is unto the beſt companies, ſcarce ever looks upon finer things, than ſhe can ſee in her cloſet, unleſs when ſhe looks into her glaſs. But, methinks, *Euſebius*, you hear and view all this with a ſilent ſeriouſneſs, which begins to make me ſuſpect, that what I thought might be an effect of your wonder, may be ſo of your diſlike.

EUSEB. The collection, *Lindamor*, is, I confeſs, very curious in its kind, and ſuch as if the miſtreſs of it were leſs handſome than ſhe is, might give her as well cauſe to be jealous of theſe fine things, as to be proud of them, ſince a beauty, that were but ordinary, could not divert a ſpectator's eye from objects, whereof many are not ſo. But, *Lindamor*, I muſt freely tell you, that I like both the lady, and the cloſet, much better than the cuſtom ſuch ſights as theſe are introducing among ladies of furniſhing ſuch kind of cloſets: I know, that youth may in certain caſes, excuſe ſome of the impertinencies it is wont to occaſion; and it is not ſtrange to me, that perſons of the fairer ſex ſhould like, in all things about them, that handſomeneſs, for which they find themſelves to be the moſt liked; nor would I forbid, even ſuch of them, as are not of a very high quality, to have a retiring place ſo neatly adorned, as may invite them to be alone, and withdraw to it, to read, or meditate, provided theſe ornaments be not ſo coſtly, as to rob charity, or ſo gaudy, as to diſtract the devotion they ſhould but accommodate. And in caſe circumſtances ſhould ſo conſpire, as that youth and quality ſhould be attended by ſuch a plentiful fortune, as that after all, that either juſtice, prudence, or decency can challenge, there remains yet enough, both to relieve the poor, and purchaſe rarities themſelves; I will not be ſo ſevere, as to condemn perſons ſo circumſtanced, nor fall out with thoſe, that are able to reconcile ſumptuouſneſs and charity. But the number of ſuch ladies, eſpecially ſo ſoon after a long civil war, muſt needs be but ſmall, and I fear much inferiour to that of thoſe, who will conſider more what they ſee done before their eyes, than they will the diſparity of circumſtances betwixt their own condition, and that of thoſe they emulate: and the greater appearance of ingeniouſneſs, as well as innocence, there is in the practice I am diſapproving, the more dangerous it is, and the more fit to be examined and decryed. For as the old ſerpent has variety of wiles, ſo he fits them to the various tempers of the perſons he aſſays to work upon; and when he meets with ladies virtuouſly diſpoſed, ſince he cannot quite eradicate their inclinations to the beſt part of religion, charity, he will at leaſt blaſt and render them fruitleſs; and he juſtly thinks, he has reached no ſmall part of his end, if though he cannot ſeduce them to do ill, he can at leaſt hinder them from doing good. And this he has of late attempted but too proſperouſly, by perſuading us to take thoſe for the ſtandard and examples of our expences, that making none of the ſcore of piety, have the more left for their vanities and their appetites; which they gratify at ſuch high rates, that thoſe, that think themſelves bound to imitate them in thoſe exceſſes, that are miſnamed gallantry, ſhall have as little ability as the other have will, to apply any conſiderable part of their eſtates to thoſe uſes, which chiefly God granted them thoſe eſtates for; and by that time, the lady her ſelf, and the houſe, and the cloſet, are furniſhed with all the ornaments, that vanity and emulation call for, there is nothing left for charity to diſpoſe of, nay, perhaps not for juſtice; the creditor being oftentimes turned back empty as well as the beggar, if not alſo made a beggar by ruinous delays. And greater fortunes, than moſt ladies have, may be exhauſted, by gratifying ſuch an ambition, as that of a cloſet, to whoſe coſtlineſs nothing can put limits, till diſcretion do; cuſtom it ſelf having not yet regulated a piece of vanity, which, as impoſing as cuſtom is wont to be, it has not yet dared to enjoin.

LIND. Methinks, *Euſebius*, you are ſomewhat forward to accuſe thoſe fair creatures, that though they ſhould want innocence, would ſcarce want advocates; and you are too good a caſuiſt to ignore, that they are wont to alledge, that the bravery you are ſo ſevere to, is no where expreſly prohibited in the Scripture; and this unforbiddenneſs they think ſufficient to evince, that the ſumptuouſneſs you ſo condemn, is not abſolutely, and in its own nature, ſinful.

EUSEB. I can readily believe, that *Lindamor* has wit and amorouſneſs enough to make him find it more eaſy to defend fair ladies, than to defend himſelf againſt them; and I know, it is ſaid, that theſe ſumptuous cloſets, and other vanities, are not ſimply unlawful in their own nature: but I know too, that divers things, not in their own nature unlawful, may be made ſo by circumſtances; and if ſo, then I fear, that that can be no other than ill, which makes a man needleſly diſable himſelf to do good. The Apoſtle, that diſcountenanced women's wearing of gold, or precious things upon their bodies, would ſure have oppoſed their having more ſumptuous ornaments upon their walls: theſe cannot pray for us, but the poor and diſtreſſed, they keep us from relieving, may either ſucceſsfully pray to God for us, or cry to him againſt us. The Scripture, that repreſents *Dives* in hell, without ſaying, that he oppreſſed or defrauded any, gives no other account of his doom, than that living at a high rate, and going richly dreſſed, he neglected to relieve the ſtarving poor. A few ſuch cloſets as this lady's might be eaſily enlarged, and contrived into an hoſpital: a ſmall part of theſe ſuperfluities would relieve the neceſſities of many families, and a liberal heart might purchaſe heaven at an eaſier rate, than the furniture of this cloſet coſt the owner of it. Nor is this practice ſo unallied to a fault, as to eſcape a puniſhment even in this world; theſe courtiers of applauſe being oftentimes reduced to live in want, even in the midſt of a plentiful fortune; theſe coſtly trifles ſo engroſſing all that they can ſpare, that they muſt ſometimes deny themſelves things convenient, and, perhaps, almoſt neceſſary, to flaunt it out with thoſe, that are neither the one nor the other, and being frequently enough fain to immolate their own inclinations and deſires, though, perchance, ſtrong and innocent, to their vanity.

And thoſe, that have once found the happineſs there is in making others happy, will think their treaſure better beſtowed in feeding hungry mouths, than idle eyes: the coſtly practice I am yet cenſuring, does not only offend charity, but ſtarve it, by ſubtracting from it that, which ſhould feed it, and enable it to act like it ſelf. And for my part, I think, he, that deviſes, and by his example brings credit to, a new expenſive way of vanity, does really deſtroy more poor, than if he uſurped an alms-houſe, or ruined an hoſpital. And by the ill precedent he leaves, he takes the way to be uncharitable, even after death, and ſo do harm, when miſers and uſurers themſelves are wont (by their legacies) to do ſome good. To conclude, it is no very Chriſtian practice to diſobey the dictates of piety, without having ſo much to plead for ſo doing, as the pretence of following the dictates of cuſtom: and it is a great deal better to be without a gay cloſet, than to be without charity, which lovelieſt of Chriſtian virtues ſhe muſt ſure very much want, that will needleſsly begin a new example to give a bad one.

## REFLECTION X.

*Upon his ſeeing a lark ſtoop to, and caught with, day-nets.*

EUSEBIUS, LINDAMOR.

EUSEB. POOR bird! thou wert juſt now ſo high upon the wing, that the tired gazers feared thou hadſt loſt thy ſelf in heaven, and in thy fatal ſtooping ſeemeſt to have brought us thence a meſſage, that ſo reliſhes of that place, that I ſhould be troubled to ſee thee ſo rudely entertained, if that circumſtance were not neceſſary to the inſtructions of thy meſſage. Some birds, you know, *Lindamor*, we uſually beguile with chaff, and others are generally drawn in by appropriated baits, and by the mouth, not the eye. But the aſpiring lark ſeems compoſed of more ſprightly and refined materials; ſhe is ever a natural, though no native, Perſian; and the ſun makes not a cloudleſs viſit to our horizon, which that grateful creature gives not a welcome to, both by notes, which, could he hear them, he would think worthy of him, and by a flight as aſpiring, as if ſhe meant he ſhould hear them; and, in a word, ſo conſpicuous is this creature's fondneſs of light, that fowlers have deviſed a way to catch her by it, and pervert it to her ruin: for placing broken looking-glaſſes upon a moveable frame betwixt their nets, the unwary bird, while ſhe is gazing upon that glittering light the glaſs reflects, and ſporting herſelf in thoſe beams, which derive a new glory from their very being broken, heedleſsly gives into the reach of the ſurprizing nets, which ſuddenly cover her, and which the light itſelf kept her from ſeeing. The devil is like this fowler, *Lindamor*; and you, or I, had perhaps reſembled the unhappy lark, if ſometimes providence did not both graciouſly, and ſeaſonably, interpoſe, and even when we were come near enough to have been covered by the nets, reſcued us from them; for it has ever been that old ſerpent's policy, and practice, to take the exacteſt meaſure of our inclinations, that he may ſkilfully ſuit his temptations to them; well knowing, that that dexterity gains him a devil within us, that conſpires with him without us, to make us inſtances of that truth, which repreſents things divided againſt themſelves as ruinous. If therefore the tempter find by experience, that you are indiſpoſed to be wrought upon by common temptations, to forget the practice of religion, that you have unconcernedneſs enough not to be much diſtracted with the empty and trifling chaff, youth is wont to be caught with, (which perhaps ſeldom employ any of your thoughts ſo much as thoſe of ſcorn, and pity) that the very gain and ſolider goods of this world (for which many, thought wiſe men, loſe thoſe of the next) cannot make you ſo greedy, nor ſo fond of them, as he deſires: if, I ſay, the devil have ſufficiently obſerved, how uneaſy it were to intice you with common baits, he will alter his method ſtrait, and attempt to catch you with light. He knows as well as I do, that you have a curioſity, or rather a greedineſs of knowledge, that is impatient of being confined by any other limits than thoſe of knowledge it ſelf; and accordingly, ſeldom, or perhaps never diſturbing or frightening you, he will let you freely ſport your ſelf about the glittering intellectual glaſs, men call philoſophy, and ſuffer you not only to gaze upon all its pieces, and ſurvey a pretty number, but, peradventure, pry into more than one: and among ſo numerous, and delighting objects, I fear, that if you will frankly own what my own guilt makes me ſuſpect you of, you muſt confeſs, that he had made you ſo ſhare your time, that you ſhould ſcarce have left your ſelf any for heavenly themes, and the meditation of death, (which conſequently, might have then ſurprized you, had it invaded you) if providence had not mercifully ſnatched you out from between the nets you were allured to, before you were quite involved in them; and by ſickneſs, or elſe, by means (in other caſes) ſo unlikely, as outward diſtractions, called your thoughts home by driving them away from thoſe enchanting ſtudies, whoſe light might much likelier have betrayed you into the net, than have ſhewn it you.

LIND. Though I am not ſurprized to hear *Euſebius*, yet I am glad to hear a ſcholar talk at this rate, and believe with you, that many a one, that was neither crow, nor woodcock, has periſhed in this ſnare; and we have known but too many great ſcholars ſo intirely taken up with writing, and reading of books, with learning this ſcience, and with teaching that, that by ſetting themſelves ſuch taſks, as required and employed the whole man, death has undiſcernedly ſtolen upon them, and unawares intruded into their ſtudies, where their reſtleſs ambition to inrich the mind never left them the leiſure to prepare it to leave the body, but either made them ſurprized inſtances of that ſad (but true) obſervation of *Seneca*, *pleroſque in ipſo vitæ apparatu vita deſtituit*; or elſe made their condition like that of *Archimedes*, who was ſo buſy in tracing his circles, that he took no notice of that victorious enemy, that came to diſpatch him.

EUSEB. I allow, that it is the innocence, as well as pleaſure of knowledge, that deceives thoſe learned men; but they, as well as others, muſt remember, that even the wholſomeſt meats may be ſurfeited on, and there is nothing more unhealthy, than to feed very well, and do but very little exerciſe. And I take it to be as true of the intellectual, as the material world, that *it profits not a man, if he gain the whole world, and loſe his own ſoul.* Whatſoever therefore philoſophers do tell us of a wiſe man, that he is no where baniſhed, becauſe he is a citizen of the world; I muſt think a Chriſtian every where an exile, becauſe he is a citizen of the heavenly *Jeruſalem*, and but *a ſtranger and a ſojourner here.* It was not abſolutely in the capacity of the *father of lyes*, that the devil boaſted, that the earth was his dominion; for, as our Saviour ſtiled him, *the prince of this world*, I find, that he has all things here ſo much at his devotion, that there is no place, that he cannot lay an ambuſh in, ſince he can pervert even light itſelf, to hide his ſnares. Let us, therefore, hereafter endeavour ſtill to ſtand upon our guard, as remembering our ſelves to be in an enemy's country, where diſtruſt is the only mother of ſafety; and ſince providence has ſo graciouſly preſented us a leſſon, our books would not have taught us, againſt ſuch a fondneſs of them, as is injurious to piety, and dangerous to the ſoul; let us juſtify, better than this ſilly lark has done, that ſaying of *Solomon*, *ſurely in vain the net is ſpread in the ſight of any bird.* Let not philoſophy any more take up our life ſo, as not to leave us leiſure to prepare for death, and ſtudy a ſcience, which ſhall moſt benefit us in another world, and which alone will do ſo there. No, we may viſit *Athens*, but we ſhould dwell at *Jeruſalem*; we may take ſome turns on *Parnaſſus*, but ſhould more frequent mount *Calvary*; and muſt never ſo buſy our ſelves about thoſe *many things*, as to forget that *unum neceſſarium, that good part, which ſhall not be taken away from us.*

# OCCASIONAL REFLECTIONS.

## THE LAST SECTION.

### REFLECTION I.

*Seeing a child picking the plums out of a piece of cake his mother had given him for his breakfaſt.*

EUSEBIUS, LINDAMOR.

EUSEB. THIS child is ſo much one in his humour, that deſpiſing meer bread, though never ſo nouriſhing and wholeſome, his mother is fain to diſguiſe the materials of it into cake, out of a belief, that the toothſome would make the nutritive part go ſmoothly down. But this liquoriſh chit, I ſee, defeats her plot, and knows already how to nibble off the bait from the hook, and caſting by the meat, makes his whole meal of what was meant only for ſauce, to give a reliſh to what he rejects for it. This puts me in mind of the unwelcome fate thoſe papers of mine, that treat of devotion, have met with: for when I firſt was ſo unacquainted with the world, as to expect, that piety and virtue were able, by their native charms, ſo much to endear my dreſs, as to win themſelves adorers in a plain, or even a ſevere one; I ventured ſome of them abroad, though not in print, yet among my acquaintance, in a careleſs matron-like habit, in which I ſoon found they almoſt frighted moſt of thoſe I had deſigned them to work the quite contrary effects on. But when my acquaintedneſs with the genius of the age had ſadly taught me, that I was to alter my method, that the eloquence of virtue's ſermons was that, which muſt attract an auditory, and engage attention to them; and that thoſe orders of hers, in which ſhe employed not rhetorick for her ſecretary, could not be ſo much as liſtened to, much leſs obeyed, I endeavoured to cloath virtue, though not in a gaudy, in a faſhionable habit, and diveſting her not only of her ſack-cloth, but her blacks, where I ſaw ſhe appeared in them with diſadvantage, I endeavoured to give her as much of the modern ornaments of a fine lady, as I could, without danger of being accuſed to have dreſſed her like a courtezan. This attempt having not proved ſo unſucceſsful, but that many were pleaſed to aſſure me, I had not been unlucky in it, I ſpent ſome time in the ſelf-denying exerciſe of minding words, and improving a ſtyle, I hoped to be able to improve to virtue's ſervice, and ſubduing my inclinations to be fit to teach, as I had done to learn, her precepts; I ſometimes, for her ſake, tried my pen in a ſmoother, and more florid ſtyle, than that, which the nature of the ſtudies I was moſt addicted to, made the moſt familiar to me, flattering myſelf with a belief, that ſince my writings had uſually the good fortune not to be ill approved, I might ſo happily mingle and interweave inſtructions with delight, as to neceſſitate my readers to ſwallow both together, or at leaſt bribe them by the latter to entertain the former.

LIND. You have better luck, as well as better ſkill, than many others, if you find it not often to fare with the fiſhers of men, as it did with thoſe other fiſhers, that firſt were honoured with that glorious title, when they complained to our Saviour, that *we have toiled all the night, and have taken nothing*. For I ſee, that men are grown witty enough to elude what they cannot deſpiſe, and reſemble the deaf adder, that ſtops her ſpiritual ears from hearkening to the voice of charmers, be the charmer never ſo cunning. And the beſt reception, that the movingeſt eloquence, that pleads for piety, can obtain of them, is but ſuch as may ſerve to make that applicable to the preacher, which God once ſaid to a prophet, *Lo, thou art unto them as a very lovely ſong of one, that hath a pleaſant voice, and can play well upon an inſtrument*; *for they hear thy words, but they do them not*. But the beſt is, that you ſerve a maſter, that is as inclinable to reward, as able to diſcern, intentions, and does not make his eſtimates by events, but judges of our performances, not by the effects they produce, but the affections they flowed from, and the ends they aimed at. Luke v. 5

EUSEB. *The diſciple is not above his maſter, nor the ſervant above his lord.* And therefore, *Lindamor*, as I dare not repine at the unſucceſsfulneſs of my endeavours, ſo I dare think, that whilſt it proceeds but from the obſtinacy of others, it is not likely to be imputed to me by him, that complained himſelf, *that all the day long he had ſtretched forth his hands to an unperſuadable and gain-ſaying people.* Otherwiſe, I confeſs, I ſhould not have much cauſe to be ſatisfied with the return, that all my endeavours have hitherto brought me home. For I ſee, that men can read a book of devotion as unconcernedly as they do a romance or a play, in both of them culling out only what they call wit, and making no better uſe of it than either to exerciſe or improve their own. They hear the moſt pathetick ſermons, not as Chriſtians but orators; and if in ſuch diſcourſes they have been ſo juſt as to praiſe the rhetorick, they think they may well be excuſed, if they over-look the divinity: in ſhort, nothing but what gratifies their fancy can leave any impreſſions on their memory, and that itſelf, if it tend to reform them, makes none on their affections. And ſome, whoſe happier pens allow them to do it far more juſtly than I can, do complain, that if a devout book have not good ſtore of witty paſſages, they will not mind it at all; and if it have, they will mind nothing elſe.

So that, *Lindamor*, I ſhould ſometimes be diſcouraged from proſecuting endeavours, which though they now and then ſucceed, are oft-times ſo unproſperous, if I did not think with you, that they, who labour to win ſouls to God, are ſet on work by him, that having no need of our performances, ſeeks in our ſervices but the opportunities of exerciſing his own goodneſs.

## REFLECTION II.

### *Upon the ſight of ſweet-meats very artificially counterfeited in wax.*

THE ſhape and colours of the beſt ſweet-meats of theſe kinds are here ſo luckily repreſented by a ſkilful hand, that art ſeems to have deſigned rather to rival nature, than barely to imitate her, and a lover of junkets, that approaches not too near to theſe, muſt have much quickneſs of ſight, or but little of appetite, if ſuch inviting objects do not tempt him both to miſtake and to deſire them. But, though at this diſtance theſe alluring ſweet-meats appear very pleaſing, yet if one ſhould be ſo unadviſed, as to endeavour to eat them, inſtead of injoying them more fully by the taſte than he did by the ſight, he would both ſpoil and disfigure them, and perhaps be ſo near choaking himſelf, that he would more earneſtly wiſh them out of his mouth, than ever he wiſhed them in it.

world, and which alone will do ſo there. No, we may viſit *Athens*, but we ſhould dwell at *Jeruſalem*; we may take ſome turns on *Parnaſſus*, but ſhould more frequent mount *Calvary*; and muſt never ſo buſy our ſelves about thoſe *many things*, as to forget that *unum neceſſarium*, *that good part*, *which ſhall not be taken away from us.*

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# OCCASIONAL REFLECTIONS.

## THE LAST SECTION.

### REFLECTION I.

*Seeing a child picking the plums out of a piece of cake his mother had given him for his breakfaſt.*

EUSEBIUS, LINDAMOR.

EUSEB. THIS child is ſo much one in his humour, that deſpiſing meer bread, though never ſo nouriſhing and wholeſome, his mother is fain to diſguiſe the materials of it into cake, out of a belief, that the toothſome would make the nutritive part go ſmoothly down. But this liquoriſh chit, I ſee, defeats her plot, and knows already how to nibble off the bait from the hook, and caſting by the meat, makes his whole meal of what was meant only for ſauce, to give a reliſh to what he rejects for it. This puts me in mind of the unwelcome fate thoſe papers of mine, that treat of devotion, have met with: for when I firſt was ſo unacquainted with the world, as to expect, that piety and virtue were able, by their native charms, ſo much to endear my dreſs, as to win themſelves adorers in a plain, or even a ſevere one; I ventured ſome of them abroad, though not in print, yet among my acquaintance, in a careleſs matron-like habit, in which I ſoon found they almoſt frighted moſt of thoſe I had deſigned them to work the quite contrary effects on. But when my acquaintedneſs with the genius of the age had ſadly taught me, that I was to alter my method, that the eloquence of virtue's ſermons was that, which muſt attract an auditory, and engage attention to them; and that thoſe orders of hers, in which ſhe employed not rhetorick for her ſecretary, could not be ſo much as liſtened to, much leſs obeyed, I endeavoured to cloath virtue, though not in a gaudy, in a faſhionable habit, and diveſting her not only of her ſack-cloth, but her blacks, where I ſaw ſhe appeared in them with diſadvantage, I endeavoured to give her as much of the modern ornaments of a fine lady, as I could, without danger of being accuſed to have dreſſed her like a courtezan. This attempt having not proved ſo unſucceſsful, but that many were pleaſed to aſſure me, I had not been unlucky in it, I ſpent ſome time in the ſelf-denying exerciſe of minding words, and improving a ſtyle, I hoped to be able to improve to virtue's ſervice, and ſubduing my inclinations to be fit to teach, as I had done to learn, her precepts; I ſometimes, for her ſake, tried my pen in a ſmoother, and more florid ſtyle, than that, which the nature of the ſtudies I was moſt addicted to, made the moſt familiar to me, flattering myſelf with a belief, that ſince my writings had uſually the good fortune not to be ill approved, I might ſo happily mingle and interweave inſtructions with delight, as to neceſſitate my readers to ſwallow both together, or at leaſt bribe them by the latter to entertain the former.

LIND. You have better luck, as well as better ſkill, than many others, if you find it not often to fare with the fiſhers of men, as it did with thoſe other fiſhers, that firſt were honoured with that glorious title, when they complained to our Saviour, that *we have toiled all the night, and have taken nothing.* For I ſee, that men are grown witty enough to elude what they cannot deſpiſe, and reſemble the deaf adder, that ſtops her ſpiritual ears from hearkening to the voice of charmers, be the charmer never ſo cunning. And the beſt reception, that the movingeſt eloquence, that pleads for piety, can obtain of them, is but ſuch as may ſerve to make that applicable to the preacher, which God once ſaid to a prophet, *Lo, thou art unto them as a very lovely ſong of one, that hath a pleaſant voice, and can play well upon an inſtrument; for they hear thy words, but they do them not.* But the beſt is, that you ſerve a maſter, that is as inclinable to reward, as able to diſcern, intentions, and does not make his eſtimates by events, but judges of our performances, not by the effects they produce, but the affections they flowed from, and the ends they aimed at. Luke v. 5

EUSEB. *The diſciple is not above his maſter, nor the ſervant above his lord.* And therefore, *Lindamor*, as I dare not repine at the unſucceſsfulneſs of my endeavours, ſo I dare think, that whilſt it proceeds but from the obſtinacy of others, it is not likely to be imputed to me by him, that complained himſelf, *that all the day long he had ſtretched forth his hands to an unperſuadable and gain-ſaying people.* Otherwiſe, I confeſs, I ſhould not have much cauſe to be ſatisfied with the return, that all my endeavours have hitherto brought me home. For I ſee, that men can read a book of devotion as unconcernedly as they do a romance or a play, in both of them culling out only what they call wit, and making no better uſe of it than either to exerciſe or improve their own. They hear the moſt pathetick ſermons, not as Chriſtians but orators; and if in ſuch diſcourſes they have been ſo juſt as to praiſe the rhetorick, they think they may well be excuſed, if they over-look the divinity: in ſhort, nothing but what gratifies their fancy can leave any impreſſions on their memory, and that itſelf, if it tend to reform them, makes none on their affections. And ſome, whoſe happier pens allow them to do it far more juſtly than I can, do complain, that if a devout book have not good ſtore of witty paſſages, they will not mind it at all; and if it have, they will mind nothing elſe.

So that, *Lindamor*, I ſhould ſometimes be diſcouraged from proſecuting endeavours, which though they now and then ſucceed, are oft-times ſo unproſperous, if I did not think with you, that they, who labour to win ſouls to God, are ſet on work by him, that having no need of our performances, ſeeks in our ſervices but the opportunities of exerciſing his own goodneſs.

## REFLECTION II.

### *Upon the ſight of ſweet-meats very artificially counterfeited in wax.*

THE ſhape and colours of the beſt ſweet-meats of theſe kinds are here ſo luckily repreſented by a ſkilful hand, that art ſeems to have deſigned rather to rival nature, than barely to imitate her, and a lover of junkets, that approaches not too near to theſe, muſt have much quickneſs of ſight, or but little of appetite, if ſuch inviting objects do not tempt him both to miſtake and to deſire them. But, though at this diſtance theſe alluring ſweet-meats appear very pleaſing, yet if one ſhould be ſo unadviſed, as to endeavour to eat them, inſtead of injoying them more fully by the taſte than he did by the ſight, he would both ſpoil and disfigure them, and perhaps be ſo near choaking himſelf, that he would more earneſtly wiſh them out of his mouth, than ever he wiſhed them in it.

There are ſome pleaſures and conditions too in the world, which make ſo fine a ſhew at a diſtance, that in thoſe, that gaze at them aloof off, they frequently beget envy at them, and wiſhes for them; and yet he, that calmly beholds them, takes the beſt way of injoying them: ſince that, which, whilſt it is but aimed at, is expected to be very ſatisfactory upon a nearer and fuller fruition, would be ſo far from proving ſo, and would ſo little be as ſweet to the palate as ſpecious to the eye, that it would not only ceaſe to afford them any delight, but would make them wiſh they had let thoſe deluding ſweets alone, and would make attainments more uneaſy and troubleſome, than even deſire was.

## REFLECTION III.

### *Upon the eating of oyſters.*

EUGENIUS, LINDAMOR.

Eug. WHILST every body elſe is commending theſe oyſters, either with his tongue or with his teeth, ſo that one of the company ſticks not to ſay, that they are as much worth, as if they contained each of them a pearl, you only ſeemed as unconcerned a ſpectator, as if you thought their proper uſe, like that of flowers, were rather to be looked on than to be eaten.

Lind. I confeſs, *Eugenius*, that I found my ſelf more inclinable to reflect on what you are doing, than to keep you company in it; and whilſt I ſaw ſuch perſons ſo guſtfully ſwallow theſe extolled fiſhes, the ſight led me to take more notice than perhaps you have done of the ſtrange power of education and cuſtom.

Eug. And what, I pray you, has cuſtom to do with oyſters?

Lind. You will ſoon know that, if I tell you, that I was conſidering, on this occaſion, how forward we are to think other nations abſurd or barbarous for ſuch practices, that either the ſame, or little better, may be found unſcrupled at among our-ſelves; and I acknowledge it to be one of the chief advantages I account my ſelf to have obtained by my travels, that as I do not eaſily admire, ſo I am not forward to deride, the practice of any people for being new, and am not apt to think their cuſtoms muſt be therefore worſe than ours, becauſe they widely differ from them.

I could give you ſtore of inſtances to juſtify this impartiality; but becauſe the circumſtances of eating and drinking are thoſe, which make men, with the greateſt confidence, term other nations brutiſh and barbarous, I will confine my ſelf to ſome examples of that nature.

We impute it for a barbarous cuſtom to many nations of the Indians, that like beaſts they eat raw fleſh. And pray how much is that worſe than our eating raw fiſh, as we do in eating theſe oyſters? Nor is this a practice of the rude vulgar only, but of the politeſt and niceſt perſons among us, ſuch as phyſicians, divines, and even ladies. And our way of eating ſeems much more barbarous than theirs, ſince they are wont to kill before they eat, but we ſcruple not to devour oyſters alive, and kill them not with our hands or teeth, but with our ſtomachs, where (for aught we know) they begin to be digeſted before they make an end of dying. Nay ſometimes when we dip them in vinegar, we may, for ſauce to one bit, devour alive a ſhoal of little animals, which, whether they be fiſhes or worms, I am not ſo ſure, as I am, that I have, by the help of convenient glaſſes, ſeen great numbers of them ſwimming up and down in leſs than a ſaucer full of vinegar.

WE deteſt and deſpiſe ſome other nations, for feeding upon caterpillars, graſhoppers, and other inſects; and others for feeding upon carrion, and ſtinking food.

AND do not many of us do as bad, when we not only eat, but extol, rotten cheeſe, whoſe livid colour ſufficiently betrays its putrefaction, and whoſe odious ſmell offends moſt men's noſes, and turns ſome men's ſtomachs? Nay, when this cheeſe is grown to that high degree of rottenneſs, that our critical palates like it beſt in, we then devour whole hundreds of mites, which are really crawling inſects, bred out of putrefaction, and theſe too are ſo numerous and little, that our greedineſs makes us ſwallow many of them alive.

AMONG the ſavageſt Barbarians we count the Cannibals; and as for thoſe among them, that kill men to eat them, their inhuman cruelty cannot be too much deteſted; but to count them ſo barbarous, merely upon the ſcore of feeding upon man's fleſh and blood, is to forget, that woman's milk, by which alone we feed our ſucking children, is, according to the received opinion, but blanched blood; and that mummy is one of the uſual medicines commended and given by our phyſicians, for falls and bruiſes, and in other caſes too. And if we plead, that we uſe not mummy for food, but phyſick, the Indians may eaſily anſwer, that, by our way of uſing man's fleſh, we do oftentimes but protract ſickneſs and pain; whereas they by their's maintain their health and vigour. And there is no reaſon, why it ſhould be allowable to eat broth, for inſtance, in a conſumption, and be condemnable to feed upon it to maintain health.

BUT laſtly, as the higheſt degree of brutiſhneſs, our travellers mention the practice of the Soldanians, at the *Cape of Good Hope*, who not only eat raw meat, but, if they be hungry, eat the guts and all of their cattle, with the dung in them. I will not anſwer, that I know ſeveral among us, (and perhaps ſome fair ladies too) that, to prevent the ſcurvy and the gout, drink their own or boy's urine: nor that women themſelves do oftentimes take parmacitty inwardly, though the Latin name *(Sperma ceti)* ſufficiently declare what excretion of a whale it is (though perhaps miſtakenly) believed to be: nor yet, that under the name of *Album Græcum*, dog's dung is commonly given to patients of all ſorts and qualities, againſt ſore throats: nor will I mention, that in *Holland* it is uſual, as I have ſeen my ſelf, to mingle ſheep's dung with their cheeſes, only to give them a colour and a reliſh. But I will rather demand, how much leſs we do ourſelves, than what we abominate in thoſe ſavages, when we devour oyſters whole, guts, excrements, and all? nay, when not for phyſick, but only for delicacies, our courtiers and ladies themſelves are wont to make ſauce for the bodies of lobſters of that green ſtuff, which is indeed their dung. And to theſe I could add other examples, if I were not afraid to divert you too long from ſo much pleaſure, as the company ſeems to take, in eating raw fiſh.

EUG. You put me in mind of a fancy of your friend Mr. *Boyle*, who was ſaying, that he had thoughts of making a ſhort romantick ſtory, where the ſcene ſhould be laid in ſome iſland of the ſouthern ocean, governed by ſome ſuch rational laws and cuſtoms, as thoſe of *Utopia*, or the *New Atlantis*; and, in this country, he would introduce an obſerving native, that, upon his return home from his travels made in *Europe*, ſhould give an account of our countries and manners, under feigned names, and frequently intimate in his relations, (or in his anſwers to queſtions that ſhould be made him) the reaſons of his wondering to find our cuſtoms ſo extravagant, and differing from thoſe of his country. For your friend imagined, that by ſuch a way of propoſing many of our practices, we ſhould ourſelves be brought unawares to condemn, or perhaps laugh at them, and ſhould at leaſt ceaſe to wonder, to find other nations think them as extravagant, as we think the manners of the Dutch and Spaniards, as they are repreſented in our travellers books.

Lind. I diſlike not the project, and wiſh it were proſecuted by ſomebody, that, being impartial, were more a friend to fables. For when I conſider, that the name of Barbarian was given by the two nobleſt people of the earth, the Greeks and Romans, not only to all the reſt of the world, but to one another, though both thoſe nations were highly civilized, and the courtly Perſians, and other voluptuous Aſiaticks, were perhaps no leſs ſo than they; I doubt, that moſt nations, in ſtyling one another's manners extravagant and abſurd, are guided more by education and partiality, than reaſon; and that we laugh at many cuſtoms of ſtrangers, only becauſe we never were bred to them, and prize many of our own, only becauſe we never conſidered them. And we may well believe, that cuſtom has much a larger empire, than men ſeem to be aware of, ſince whole nations are wholly ſwayed by it, that do not reckon themſelves among its ſubjects, nor ſo much as dream, that they are ſo.

## REFLECTION IV.

### *Upon a lanthorn and candle, carried by on a windy night.*

As there are few controverſies more important, ſo there are not many, that have been more curiouſly and warmly diſputed, than the queſtion, whether a publick or a private life be preferable? But perhaps this may be much of the nature of the other queſtion, whether a married life or ſingle ought rather to be choſen? that being beſt determinable by the circumſtances of particular caſes. For though, indefinitely ſpeaking, one of the two may have advantages above the other, yet they are not ſo great, but that ſpecial circumſtances may make either of them the more eligible to particular perſons. They, that find themſelves furniſhed with abilities, to ſerve their generation in a publick capacity, and virtue great enough to reſiſt the temptations, to which ſuch a condition is uſually expoſed, may not only be allowed to embrace ſuch an employment, but obliged to ſeek it. But he, whoſe parts are too mean to qualify him to govern others, and perhaps to enable him to govern himſelf, or manage his own private concerns, or whoſe graces are ſo weak, that it is leſs to his virtues, or to his ability of reſiſting, than to his care of ſhunning the occaſions of ſin, that he owes his eſcaping the guilt of it, had better deny himſelf ſome opportunities of doing good, than expoſe himſelf to probable temptations. For there is ſuch a kind of difference betwixt virtue, ſhaded by a private, and ſhining forth in a publick life, as there is betwixt a candle carried aloft in the open air, and incloſed in a lanthorn; in the former place it gives more light, but in the latter, it is in leſs danger to be blown out.

## REFLECTION V.

### *Upon the firſt audience of the Ruſſian extraordinary embaſſador, at which he made his emperor's preſents.*

I SEE the general expectation, that there will be here this night a magnificent appearance, has produced one. And, as it often happens in publick ſhews, that the chief part of them is made by thoſe, that come to ſee them; ſo here, beſides them, whoſe duty obliges them to attend at the ſolemnity, there is a greater concourſe of fine people of either ſex, than any thing of this nature has for theſe many years occaſioned. And not only many of the ladies wear in their ribbands little leſs vivid colours, than thoſe of their faces, and are ſet out with jewels almoſt as ſparkling as their eyes, (which yet the courtiers think were able to warm the Ruſſian hearts, though all the ice and ſnow of their country guarded them) but the men themſelves are many of them as finely and as richly dreſſed, as if even they came as well to be ſeen as to ſee. And if the embaſſador be, what a man of his employment ſhould be, (and what ſome ſay he is) a perſon acquainted with the manners of men, he cannot but know, that we, as other nations, value our own faſhions enough, to look upon men diſguiſed by the Ruſſian dreſs, as little better than anticks, if not as ſome new kind of northern animals. But for all this gazing throng of gaudy ſpectators, that were able to put an ordinary ſtranger out of countenance, to appear in a habit differing from their's; the embaſſador, and thoſe, that come along with him, think it not fit to decline the Ruſſian habit or ceremonies for the Engliſh, but keep to the ceremonies uſed in *Muſcovy*, as ſtrictly, as if the monarch of it, that ſent him hither, ſaw them here; and are not diſcouraged from this manly proceeding, by ſeeing themſelves ſtared at for it by a number of gaudy ſpectators, that wear clothes, and uſe ceremonies, ſo differing from their's. And whatever thoſe may think of the embaſſador, that are wont to eſtimate men by the faſhionableneſs of their clothes; yet the wiſer and more intelligent do not blame him, for refuſing to diſparage the faſhions of his own people, by appearing aſhamed of them; but do rather think it prudent in him, to prefer the pleaſing of his maſter, and his own countrymen, before the gratifying of ſtrangers, ſince it is not here, but at home, that he expects the recompence of his behaviour, and embaſſy.

THUS, when a Chriſtian, who belongs to a celeſtial king, and whoſe *citizenſhip is in heaven*, being but a *ſtranger upon earth*, converſes among the *men of the world*, though in matters indifferent, there is oft-times required by prudence as much of compliance, as is allowed by innocence; yet, when there happens an occaſion, wherein he cannot comply with the depraved cuſtoms of thoſe, among whom he lives, without diſobeying him, for whom he lives, and whoſe ſervant he is, or doing ſomething, that would derogate from the dignity of a perſon related to ſuch a maſter, he will then leſs conſider, what may be thought of him by a multitude, than what account he is to render to him, who has forbidden men *to follow a multitude to do evil*. And as he knows, that his reward would be much leſs than he reckons upon, if it were a thing to be received on earth, not in heaven; ſo, how ſtrange and unfaſhionable ſoever his conformity to the orders of his own ſovereign may appear, he chuſes rather to diſpleaſe men than God, and acts, as both *ſeeing*, and being ſeen by, *him that is inviſible.*

### *A continuation of the* DISCOURSE.

AND this ought to be more eaſy to him, than their ſingularity is to the Ruſſians, I have been mentioning; for whereas theſe, if they be knowing, and impartial, refuſe our modes and rites, not becauſe they are worſe, but only becauſe they are other than thoſe of their country; he refuſes to conform to the forbidden faſhions of this world, not for their being different from thoſe of the kingdom he belongs to, but for their being bad, and condemned by him, that cannot err: whereas, of the oppoſite practices, the ſame infallible judge pronounces, by the mouth of a perſon by him inſpired, that *theſe are the good things, and the profitable unto men.* And whereas Tit. iii. 8.
theſe ſtrangers ſee nothing in this magnificent aſſembly, whoſe faſhions they decline, fit to be deſpiſed, but ſee ſome perſons in it, to whom they pay a great reſpect, and who deſerve it upon another account, than that of their wearing crowns; thoſe, that are loyal to virtue, have cauſe to look upon thoſe they refuſe to be like, with a noble, and juſt indignation, as perſons that have degraded themſelves, and by unworthy practices blemiſhed, and almoſt forfeited, the dignity of their nature, and the nobler title of Chriſtians. And, whereas theſe Muſcovites are morally certain, that we ſhall

never prefer their faſhions to our own, the Chriſtian has as great an aſſurance, that thoſe, whoſe practices he diſſents from, will one day repent, that their's diſſented from his, and will wiſh they had imitated what they now ſeem to ſcorn. And however, when he ſhall come to the celeſtial city he belongs to, he will be in no danger to be derided for the ſake of piety, ſince thoſe, that deride piety, will not be admitted there. And as theſe Ruſſians could not take a better way, than that of not ſneaking, to avoid the having their rites and perſons undervalued; ſo for a Chriſtian not to bluſh at his unfaſhionableſt practices, ſeems the hopefulleſt way to keep them and him from being ſcorned, eſpecially with thoſe, who having themſelves no quality better than confidence, value it moſt in others. And ſure it were a very unlikely way, to keep others from deſpiſing the cuſtoms of the heavenly *Jeruſalem*, for him, that belongs to it, to appear aſhamed of them himſelf. Nor have pious perſons cauſe to be out of countenance, at the ſingularity even of a ſtrictly virtuous deportment, ſince, being (as the Scripture tells us ſuch men in general are) *fellow-citizens with* the ſaints and domeſticks of God, they cannot juſtly be blamed, if they aſpire to be as like as they can here, to thoſe, whom they deſire and hope to be perfectly like hereafter. And if the angels (as the Scripture in ſeveral places ſeems to intimate) are witneſſes of our actions, the ſmalleſt number of unfaſhionable good men may, upon that ſcore, ſay to one another, as the Prophet did to his ſervant, upon the account of the heavenly hoſt that ſurrounded him, *Fear not, for they that be with us are more than they that be with them.* And the approbation of theſe illuminated, happy, and glorious ſpirits, is ſure more conſiderable than that of mortal, and, which is worſe, of ſenſual men, whether we conſider their number, or their judgments. And however, the day will come, when thoſe, that deſpiſe their ſingularity, will envy his happineſs; one welcoming ſmile from Chriſt will make him amends for all the ſcornful ſmiles of ſinful men; and the ſentence of abſolution, and bliſs, ſolemnly pronounced before God, angels, and men, will not only recompenſe him for the world's diſ-eſteem, but ſhew, that he did not deſerve it.

2 Kings vi. 16.

## REFLECTION VI.

*Upon the ſight of roſes and tulips growing near one another.*

IT is ſo uncommon a thing to ſee tulips laſt till roſes come to be blown, that the ſeeing them in this garden grow together, as it deſerves my notice, ſo methinks it ſhould ſuggeſt to me ſome reflection or other on it. And perhaps it may not be an improper one, to compare the difference betwixt theſe two kinds of flowers, to the diſparity, which I have often obſerved, betwixt the fates of thoſe young ladies, that are only very handſome, and thoſe that have a leſs degree of beauty recompenſed by the acceſſion of wit, diſcretion, and virtue: for tulips, whilſt they are freſh, do indeed by the luſtre, and vividneſs, of their colours, more delight the eye than roſes; but then they do not alone quickly fade, but as ſoon as they have loſt that freſhneſs, and gaudineſs, that ſolely endeared them, they degenerate into things not only undeſirable, but diſtaſteful; whereas roſes, beſides the moderate beauty they diſcloſe to the eye (which is ſufficient to pleaſe, though not to charm it) do not only keep their colour longer than tulips, but when that decays, retain a perfumed odour, and divers uſeful qualities, and virtues, that ſurvive the ſpring, and recommend them all the year. Thus thoſe unadviſed young ladies, that becauſe nature has given them beauty enough, deſpiſe all other qualities, and even that regular diet, which is ordinarily requiſite to make beauty it ſelf laſting, not only are wont to decay betimes, but as ſoon as they have loſt that youthful freſhneſs, that alone endeared them, quickly paſs from being objects of wonder, and love, to be ſo of pity, if not of ſcorn; whereas thoſe, that were as ſollicitous to enrich their minds, as to adorn their faces, may not only with a mediocrity of beauty be very deſirable, whilſt that laſts, but notwithſtanding the receſs of that, and youth, may, by the fragrancy of their reputation, and thoſe virtues and ornaments of the mind, that time does but improve, be always ſufficiently endeared to thoſe, that have merit enough to diſcern and value ſuch excellencies; and whoſe eſteem and friendſhip is alone worth their being concerned for. In a word, they prove the happieſt, as well as they are the wiſeſt, ladies, that whilſt they poſſeſs the deſirable qualities, that youth is wont to give, neglect not the acquiſt of thoſe, that age cannot take away.

## REFLECTION VII.

(Taken out of the 2d book of the * martyrdom of *Theodora*, and turned into an Occaſional Meditation.)

* An unpubliſhed piece of the author's.

*Upon the ſight of a branch of coral among a great prince's collection of curioſities.*

THE preſent and future condition of a Chriſtian, eſpecially of a martyr, is not ill repreſented by what we take notice of in coral; for whilſt that ſhrub yet lives, and remains faſtened to its native earth or ſoil, it grows in an obſcure region of the world, and is perpetually ſurrounded, and over-flown, by the brackiſh and unpleaſant waters of the ſea, and oftentimes expoſed to the irregular agitation of its waves. Beſides, the ſubſtance of this plant (as thoſe that ſhould know inform us) is but ſoft and tender under water, and its colour but ſad and unlively: nor is it, like the tulip or the roſe-buſh, adorned with any pleaſant verdure, and much leſs does it flouriſh with gaudy colours. And whilſt it remains under water, the excellency of it does ſo little diſcloſe it ſelf, that men ſail over it without ſuſpecting or dreaming they have any thing of precious under their feet; and by the fiſhes, in whoſe region, or rather element it grows, it is paſſed by wholly unregarded: but when this unheeded coral comes to be torn off from its root, and plucked out of his ſoil, and ſo is killed in the capacity of a plant, it then exchanges the dark and unquiet place it was confined to, for a more elevated and lightſome region; and inſtead of ſharing the fate of common ſhrubs and flowers, firſt to degenerate into fading colours and offenſive ſmells, and then to periſh, either by rottenneſs or fire, our coral, by the violence offered to it, acquires a delightful redneſs, together with a ſolidity and a durableneſs, that makes it a thing ſo lovely and immortal, that it ſerves for an ornament for the cabinets of the curious; and what ſtupid fiſhes do not at all regard, thoſe nobler creatures, men, do ſo highly prize, that oftentimes it finds place even among the rarities of princes.

THUS, a true Chriſtian, whilſt he is yet confined to the region of the animal life, lives oftentimes in an obſcure and low condition, and far from that proſperous ſtate, wherein the world's favourites are wont to flouriſh: he is almoſt perpetually expoſed to preſſures and afflictions; and either moſt men conſider him not at all, or thoſe, that look at his outſide only, are apt to deſpiſe him, becauſe it is ſo homely. And he is not only in ſuch a (ſeemingly forlorn) condition, as made the Pſalmiſt complain of himſelf, that *all the waves paſſed over him*; but (like thoſe plants of coral, that, not growing ſo near the ſhore, are conſtantly covered with water, as well as ſometimes diſordered by ſtorms) the calamities, that do, as it were, overwhelm him, are never altogether removed, even in the intervals of thoſe tempeſtuous fits, which increaſe his diſtreſſes: but when the violence of ſickneſs, or the fury of a perſecutor ſhall have taken away his life, he muſt be then tranſlated into a higher and happier region, afflictions and diſtreſſes will be all left behind. And when the ſenſual idolizers of their bodies ſhall be condemned to have thoſe as loathſome as were their minds, and as reſtleſs as their guilty conſciences, his body will obtain new and glorious qualities like that of his redeemer, and his ſoul ſhall find no leſs happy a transfiguration; the *mortal part will be ſwallowed up of life, that perfection, which is but in part, ſhall be done away.* And theſe newly acquired excellencies of the whole man will never after vaniſh or decay. And he, that lived unregarded by the ſtupid inhabitants of the earth, ſhall be joyfully welcomed into the bleſt ſociety of celeſtial ſpirits; and, what is infinitely more, be graciouſly welcomed and dignified by the Son of God himſelf. Men ſhould not therefore, by a Chriſtian's preſent ſtate, take their meaſures of his future fate, but rather ſhould remember, that he, who ſaid of ſuch, *They ſhall be mine in the day when I make up my * ſpecial treaſures,* is one, whoſe eſtimate of perſons and conditions we may ſafely rely upon, ſince he is able to make any of them infallibly ſuch as he pleaſes to pronounce them, and conſequently we may look upon the conſtant Chriſtian's differing condition, with his eyes, that ſaid, *We are now the ſons of God, and it does (not indeed) yet appear what we ſhall be, but we know, that when he ſhall appear, we ſhall be like HIM*; who would be like himſelf alone, did not his goodneſs vouchſafe to exalt thoſe that love him, to a likeneſs, which makes them very unlike the glorioueſt things we here admire, by incomparably tranſcending them.

2 Cor. v. 4. τὸ θνητὸν.

Mal. iii. 17.
* Segullah.

2 Joh. iii. 2.

## REFLECTION VIII.

### *Upon the ſight of the effects of a burning glaſs.*

IT is a fault incident to many good men, to be too much indiſpoſed to entertain the precepts of virtue, as ſuch excellent things deſerve, in caſe thoſe, that teach them, do not practiſe them. There are too many, that do not think themſelves obliged to take even the wholeſomeſt advice from thoſe, whom they ſee more careful to give it others, than to follow it themſelves. And ſome of them are ſo nice, that they will ſcarce read a book of devotion, unleſs it come, like that St. *John* eat in the *Apocalypſe*, from the hand of an angel. But for my part, though I hope I both value and deſire religious preachers as much as the reſt of my brethren, yet I think it would be much to the injury of Scripture and of reaſon, if we ſhould ſuffer the perſonal faults of men to keep them from doing that good, their nature fits them for. The etymology of the goſpel importing its being welcome news, it is pity, that any one that teaches it ſhould not have a title to the character *David* gave *Ahimaaz*, of whom he ſaid, that *he is a good man, and brings good tidings.* But my deſirouſneſs of piety in a preacher is more for others ſake than mine. For I know not why truth, which is an intellectual thing, ſhould loſe its nature by any moral viciouſneſs in the propoſer. I know there is ſomething extraordinary in the caſe of *Noah*, who awoke from his wine, and immediately propheſied, and yet the event verified his predictions. Our Saviour inſtructing his diſciples about the Scribes and Phariſees, who ſat in *Moſes*'s chair, at the ſame time commands them to conform to their doctrine, when he forbids them to imitate their example. The wiſe-men did not the leſs find Chriſt at *Bethlehem*, though the prieſts and Phariſees ſent them without accompanying them thither. And the Aſſyrian general was cured of his leproſy by following the Prophet's preſcription conveyed him by that *Gehazi*, who, by his unworthy carriage in that buſineſs, tranſplanted (if I may ſo ſpeak) that foul diſeaſe into himſelf and his poſterity. I will therefore conſider ſermons more than preachers: for as in a burning-glaſs, though the ſun-beams do but illuſtrate, not heat, it in their paſſage, they may yet, by its aſſiſtance, kindle ſubjects, that are more diſpoſed to receive their action: ſo thoſe very truths and notions of a learned preacher, which do but enlighten him, may inflame his hearers, and kindle in their hearts the love of God. And as if a perfume be ſet on fire by the beams projected through a burning-glaſs, (which they do not ſo much as warm in their paſſage) the ſcent is no leſs odoriferous and grateful, than if it had been produced by an actually burning coal. So neither is that devotion, which is kindled by the eloquence of an indevout preacher, any whit the leſs acceptable to God for their not being themſelves affected with the zeal they beget in others. And what the book of *Kings* relates of *Eliſha*'s bones, contains a far greater miracle in the hiſtorical, than in the allegorical ſenſe, in which it is no ſuch wonder to ſee a man raiſed to life by a dead prophet.

## REFLECTION IX.

### *Upon the finding a horſe-ſhoe in the high-way.*

THE common people of this country have a tradition, that it is a lucky thing to find a horſe-ſhoe. And though it was to make my ſelf merry with this fond conceit of the ſuperſtitious vulgar, I ſtooped to take this up; yet now I obſerve in it a circumſtance, that may, for aught I know, ſomewhat juſtify the tradition. For I take notice, that though horſe-ſhoes are by travelling worn out, yet if they had a ſenſe of their own condition, it might afford them ſome conſolation in it, that the ſame journies, that waſte them, make them both uſeful and bright. Whereas, though the horſe-ſhoe I have taken up have not been conſumed upon the account of travelling, it has been eaten up by ruſt, which waſtes it as well as attrition would have done, but does not give it the luſtre it would have received from that. I meet with many, who, very unmindful, that he, who was juſtly ſtyled the wiſeman, whoſe counſel it was, that *what ever our hand finds to do, we ſhould do it with all our might*, &c. make it the main buſineſs of their life merely to lengthen it, that are far more ſolicitous to live long, than well, and would not undergo the leaſt labour, or endure the leaſt hardſhip, to do the greateſt good, but had rather loſe an hundred opportunities of ſerving God, or obliging men, than an entertainment, or an hour's ſleep, and all this under the pretence of minding their health, and complying with the dictates of ſelf preſervation. But I have often obſerved too, that even theſe jolly people, that ſeldom have a ſerious thought, but how to avoid ſerious imployments, may, by making their whole lives a ſucceſſion of divertiſements, or rather a conſtant diverſion from the true end of them, make their lives indeed thereby uſeleſs, but not at all immortal. And truly, fevers, pleuriſies, and other acute diſeaſes, that are home-bred, beſides thoſe numerous fatal ones, that are caught by contagion, and a multitude of caſualties, do cut off ſo many before they reach old age, in compariſon of thoſe, that the diligence, and induſtry, impoſed by religion, or curioſity, deſtroy, that I think ſo great a fear of uſing the body for the intereſts of the ſoul, and of him to whom we owe both, does very little become his diſciples, who ſaid, that it was *his meat to do the will of God that ſent him, and to accompliſh his work.* John iv. 34. The trouble of thirſting, and ſweating, and undreſſing, would to an ingenious man be but juſt recompenſed by the bare pleaſures of eating, and drinking, and ſleeping: to confine an honeſt and inquiſitive perſon from thoſe, which he looks upon as the almoſt only manly employments, the exerciſe of virtue, and the purſuit of knowledge, by telling him, that ſuch a forbearance may protract his life, is to promiſe a thing upon a condition, that deſtroys the end and uſe of it; and he will look upon it, as if you ſhould offer him a horſe, provided he will not ride him, or a perſpective-glaſs, upon condition he ſhall not draw it out, for fear the air ſhould, as it ſometimes does, impair the glaſſes. A heaven-born ſoul would ſcarce think it worth while to ſtay here below, if its work muſt be, not to employ the body, but to tend it. Thoſe, that are ſo unreaſonably afraid to ſpend their ſpirits, are in ſome regards leſs excuſable than miſers themſelves; for though both hoard up things, that cannot be better injoyed, than by being parted with, the chief uſes for which they were intruſted with them: yet in this, thoſe I blame are more cenſurable, than the covetous themſelves, ſince theſe, by their niggardlineſs, can avoid ſpending their money, but the others, by their lazineſs, cannot avoid the conſumption of their time. I know a man may be prodigal of himſelf, as well as his eſtate; and that both thoſe profuſions are faults, and therefore fit to be declined. But if I could not ſhun both the extremes, certainly, ſince we all muſt die, and the queſtion is not, whether or no we will live for ever, (for the moſt, that can he hoped for, is not to be privileged from death, but only to be longer reprieved) but whether we will rather endeavour to lead a life, mean, and unprofitable, a few more days, or a glorious life, for a ſomewhat leſs number of them? I ſhould rather chuſe to ſpend my life quickly, than uſeleſly; for he, that lays out himſelf for eternity, if he loſe any portion of his time upon that account, is the ſooner put into poſſeſſion of an inexhauſtible ſtock of it; whereas thoſe, who, that they may live long, meanly forego the ends of living, and ſeek, by lazineſs, to protract an inſignificant ſtay on earth, would, ſhould they reach their aim, add rather to their years than to their life.

## REFLECTION X.

At the Hague.

*Upon the ſhop of an ugly painter rarely well ſtored with pictures of very handſome ladies.*

GENORIO, EUSEBIUS, LINDAMOR.

GENOR. HERE is a deceitful ſhop of beauty, where many, that come but to wonder, meet with love, and even when they buy not what they like, pay their hearts for it; the ſhop being ſo well furniſhed, that beauty ſeems here to have aſſumed all the variety of features, and complexions, ſhe can be dreſſed in, and ſo exquiſitely to have fitted all gazers with proportionate and attractive objects, that nothing but an abſolute incapability of love is here able to protect them from that paſſion, which, not to reſent among ſo many inſpiring wonders, were one. If in theſe faces, the originals equal the tranſcripts; if art have not flattered nature, and attempted more to inſtruct than imitate her; and if the painter have not elected, rather to have his pieces liked, than like, here are apologies for love, that can procure it, not only pardons, but proſelytes. I muſt (in that caſe) add, that there are more ſuns than one, whoſe brightneſs, even by reflection, can dazzle; here are princeſſes more illuſtrious for the blood, that lightens in their cheeks, than for that, which runs in their veins, and who, like victorious monarchs, can conquer at a diſtance, and captivate by proxy.

EUSEB. I fear, *Genorio*, that you are ſo tranſported with your text, that you will quite forget (if ever you intended it) to make a homily upon it: for you talk at ſuch a rate, as if you were about to loſe, to the pictures of ladies, the liberty, your friend Mr. *Boyle* would be thought to have ever defended againſt their originals, and fancied, that it might add to the other reſemblances you ſo admire betwixt them, if both of them were made enemies to ſeriouſneſs.

Lind. I preſume, *Genorio* will willingly allow me to ſerve him at this turn: for whether or no he meant us a reflection, ſome charms or other he has met with in theſe pictures, ſeem to have ſo arreſted his thoughts, as well as his looks, that we ſhall not have them haſtily delivered from ſo pleaſing a captivity; and the knowledge I alone, of us three, have of the drawer of theſe pictures, ſupplies me with a circumſtance, without which, I ſhould not, when *Euſebius* is by, offer at an occaſional meditation. But upon this advantage, I ſhall venture to tell you, that the thing I was conſidering, was, that though the limner have drawn ſome pieces, as handſome as lovers think, or wiſh their miſtreſſes, and ſome (as they tell me) ſo like, that an actual confrontation of the artiſt's works, and nature's, would ſcarce diſtinguiſh them, (ſince the former would appear to differ from the later, but in that ſilence, which the later's admiration, to ſee themſelves ſo perfectly repreſented, would impoſe) yet is the painter himſelf ſo deformed a creature, that he might draw a lovelier face even than any here, by drawing one perfectly unlike his own. Alas! this diſcloſes the difference there may be betwixt the being able to write fine characters of virtue, and the poſſeſſing of it. How ridiculous ſhould I eſteem this limner, if with all his uglineſs, he ſhould eſteem himſelf handſome, becauſe his pencil can draw faces that are ſo! As abſurd were it for us, to grow proud of our devout compoſures, and fancy piety ours, becauſe our diſcourſes can poſſibly inamour others of it. The devil ſometimes does unmoleſtedly ſuffer us to write well, if he can but perſuade us we need do no more, and that good pens may diſpenſe us from good actions. Our paper-wars againſt vices are oftentimes like *Alexander*'s againſt the neighbouring nations, not out of hatred, but glory, not to extirpate, but to conquer them, and manifeſt to the world the ſufficiency of our parts, by a victory, after which we often treat the vanquiſhed enemy with greater courteſy, than thoſe, whoſe quarrel we undertook. Diſcourſes againſt vices may be as well indited by vanity, as by zeal, and meant to expreſs wit, not perſuade piety. And if (as it chanced but too frequently) we grow proud of them, we do, like witches turning exorciſts, only comply with Satan to caſt out the devil.

Euseb. To ſecond your pious reflection, *Lindamor*, with ſome thoughts ſuitable to my profeſſion, I will add, that in the caſe you put, it happens to us as it once did to *Gideon*, who, of the ſpoils of God and *Iſrael*'s conquered enemies, made an idol, which proved, in the end, his, and his houſe's ſnare. It was a moſt inſtructive check, and divine admonition, that our Saviour gave his Apoſtles, when, in the account they brought him of their embaſſy, they joyfully related their exerciſed power, of diſpoſſeſſing devils; *notwithſtanding* (anſwered Chriſt) *in this rejoice not, that ſpirits are ſubject to you, but rather rejoice, that your names are written in heaven.* In effect, though *Judas* were one of the perſons, inveſted with this miraculous power of caſting devils out of others, yet we read, that *Satan* afterwards *entered into* Judas, *and that it had been good for him, that he had never been born.* And though, as *Solomon* tells us, *he that winneth ſouls, is wiſe,* yet it is he only, that ſhall *do,* as well as *teach,* the commandments, *that ſhall be called great in the kingdom of heaven.* And the judge himſelf informing us that, at the world's laſt day, many will plead their *having in his name not only propheſied or preached, but caſt out devils,* and ſhall yet be diſclaimed by him, ſufficiently intimates, that it is as poſſible, as unavailable, *to do many wonderful works* (for religion) and to be *workers of iniquity.* The true Chriſtian ſhould, *Lindamor*, be willing to impart any uſeful diſcoveries, that God ſhall pleaſe to vouchſafe him; but he will ever conſider the takingeſt notions he can frame of virtue, more as engagements to it, than arguments of it: and ſince there is not any thing, in which charity ought more to begin at home, than in devout inſtructions, he will

Judg. viii. 24, 25, 26, &c.

Mat. v. 19.

Mat. vii. 22, 23.

endeavour to make himſelf as much piety's votary, as advocate; to imitate thoſe truly wiſemen, that, as they informed thoſe of *Jeruſalem* of the ſtar they had ſeen in the eaſt, did themſelves follow it, till it brought them unto Chriſt; to entitle himſelf to that of our Saviour, *a good man out of the good treaſure of his heart, brings forth good things:* and (finally) to take his celebrations of virtue from his experience, not his fancy; as nurſes firſt feed themſelves, to nouriſh their ſucking infants, to whom they give no meat, which they have not in their own breaſts firſt digeſted into milk, leſt (like the carpenters, that toiled to build the ark to ſave *Noah* from the deluge, themſelves periſhed in) *when he has preached to others, he himſelf ſhould prove a caſt-away.* Luke vi. 45. 1 Cor. ix. 27.

### *A continuation of the diſcourſe.*

GENOR. SURE, gentlemen, it is a happy thing to be able to convert the meaneſt things to the nobleſt uſes, and make whatever one pleaſes ſubſervient to piety, by ſkilfully imploying even ſlight and unpromiſing occaſions, to repreſent her, with the advantages of a varied and ſurprizing dreſs, whereby you may procure that virtue lovers, and your ſelves friends: for her votaries are ſo ingenuous and diſintereſted in their amours, that they have as well a kindneſs for their rivals, as their miſtreſs.

LIND. I will not deny, but that there may be perſons ſo inflamed with heavenly love, that their devotion is able, like the laſt fire, that is to refine or deſtroy the world, to turn all things into fuel for its victorious flames; and who, when they are once ingaged in meditation, can make their pious thoughts excite themſelves and flame up higher, and higher, without the aſſiſtance of other incentives, than what their own fervency procures them; as it is obſerved, that when the fire has ſeized upon a town, by how ſmall a ſpark ſoever it have been kindled, if the flame come to be very great, though the air be very calm, the fire it ſelf will produce a wind, that without the help of bellows ſhall ſtrongly blow it, and make it blaze the more, and aſpire towards heaven. But, *Genorio*, whenever (for I anſwer but for my ſelf) I ſhall meet with any ſuch happy contemplators, I ſhall have the juſtice to be one of their admirers, without having the vanity to pretend to be one of their number.

EUSEB. And I, for my part, ſhall tell you, *Genorio*, that though there may be divers charitable perſons, beſides your ſelf, that by the expreſſions it becomes me to uſe in ſome of my meditations, and other compoſures of the like nature, may be apt to fancy that I am my ſelf as devout as I endeavour to make my readers, yet you muſt not imagine that my mind, like one of thoſe writings, has no other thoughts than religious, or at leaſt moral ones; for thoſe may be the productions, not of a conſtant frame of mind, but of occaſional fits of devotion: and you may read a greater number of ſuch reflections in an hour than, perhaps, I have made in a month, not to ſay in a year. And I muſt ingenuouſly confeſs to you, that I think it more eaſy to make ten good ſermons than to practiſe one, and to declaim againſt all ſins than to relinquiſh any: there goes much leſs ſelf-denial to conform to the precepts of *Cicero*, than to thoſe of Chriſt; and I find it ſo much leſs difficult to excite other men's paſſions, than to command my own, that if you will not ſuffer your charity too much to injure your judgment, you muſt look upon the devouter paſſages you may have met with among my compoſures, as expreſſions of what I aim at, rather than of what I practiſe.

## *An Account of a very odd monſtrous Calf*; *printed firſt in the* Philoſophical Tranſactions, N° I. p. 10. Anno 1665.

BY the ſame noble perſon [Mr. *Boyle*] was lately communicated to the Royal Society an account of a very odd monſtrous birth, produced at *Limmington* in *Hampſhire*, where a butcher, having cauſed a cow (which caſt her calf the year before) to be covered, that ſhe might the ſooner be fatted, killed her when fat, and opening the womb, which he found heavy to admiration, ſaw in it a calf, which had begun to have hair, whoſe hinder legs had no joints, and whoſe tongue was, *Cerberus*-like, triple, to each ſide of his mouth one, and one in the midſt: between the fore-legs and the hinder-legs was a great ſtone, on which the calf rid: the ſternum, or that of the breaſt, where the ribs lie, was alſo perfect ſtone; and the ſtone, on which it rid, weighed twenty pounds and a half: the outſide of the ſtone was of a greeniſh colour, but ſome ſmall parts being broken off, it appeared a perfect free ſtone. The ſtone, according to the letter of Mr. *David Thomas*, who ſent this account to Mr. *Boyle*, is with Doctor *Haughteyn* of *Saliſbury*, to whom he alſo referred for further information.

## *An Obſervation imparted to the noble Mr.* Boyle, *by Mr.* David Thomas, *touching ſome particulars further conſiderable in the* Monſter, *mentioned above*; *printed firſt in the* Philoſophical Tranſactions, N° II. p. 20.

UPON the ſtricteſt inquiry, I find by one, that ſaw the monſtrous calf and ſtone, within four hours after it was cut out of the cow's belly, that the breaſt of the calf was not ſtony (as I wrote) but that the ſkin of the breaſt and between the legs of the neck (which parts lay on the ſmaller end of the ſtone) was very much thicker, than on any other part; and that the feet of the calf were ſo parted, as to be like the claws of a dog. The ſtone I have ſince ſeen; it is bigger at one end than the other; of no plain ſuperficies, but full of little cavities. The ſtone, when broken, is full of ſmall pebble ſtones of an oval figure: its colour is grey like free-ſtone, but intermixt with veins of yellow and black. A part of it I have begged of Dr. *Haughteyn* for you, which I have ſent to *Oxford*, whither a more exact account will be conveyed by the ſame perſon.

# NEW
# EXPERIMENTS
# AND
# OBSERVATIONS
# TOUCHING
# COLD:
# OR,
# An Experimental Hiſtory of COLD begun.

To which are added,
An EXAMEN of *ANTIPERISTASIS*, and
An EXAMEN of Mr. *HOBBES*'s Doctrine about COLD.

Whereunto is annexed an ACCOUNT OF FREEZING, brought into
The ROYAL SOCIETY by the learned Dr. *C. MERRET*, a Fellow of it.

Together with an *APPENDIX*, containing ſome promiſcuous EXPERIMENTS
and OBSERVATIONS relating to the precedent Hiſtory of COLD.

*Non fingendum, aut excogitandum, ſed inveniendum, quid natura faciat, aut ferat.* BACON.

## *The Publiſher to the Reader.*

A GREAT progreſs having been made at the preſs in the ſecond edition of the *Hiſtory of Cold*, before the author was acquainted with it, he did not think fit to make any alteration of the former edition, but left it to come forth this year, juſt as it was printed ſeventeen years ago, *viz.* in the year 1665.

FOR the ſame reaſon, the author declined making any alteration in the introductory preface; whoſe prolixity ſeemed very excuſable, becauſe it was not barely a preface to the particular book, whereunto it was prefixed, but (as the title was deſigned to intimate) contained divers conſiderations introductory to the *Hiſtory of Cold* in general, and ſuperadded divers experiments and obſervations to thoſe, that were delivered in the hiſtory itſelf.

THE author thinks he may juſtly hope, that equitable readers will not look upon the thermometrical diſcourſes, that are premiſed to the *Hiſtory of Cold*, as unfit to appear again with it; though ſome of the particulars, that are there delivered as paradoxal,

doxal, are now acknowledged for truths by moſt of the Virtuoſi; and others, that are propoſed as new obſervations and practices, are, at preſent, come into common uſe among the curious. For the ancient date of theſe diſcourſes will eaſily make it appear, that the things they mainly conſiſted of, were then novelties. And he hopes it will not diſparage them among the equitable readers, that many have ſince thought fit to embrace the opinions, and make uſe of the practices there propoſed.

But it will be now expected, that ſomewhat ſhould be ſaid about the following Appendix, wherein the author is very ſenſible, that he ſtands more in need of the reader's equity and favour. For, not being ſollicited to make a ſecond edition, (after men's curioſity and the fire of *London* had diſperſed or deſtroyed the firſt) till want of leiſure made him unwilling, and want of health almoſt unable, to reviſe and proſecute that work; he threw aſide the particulars he intended to add among other looſe papers, where for many years they lay neglected, and probably there were divers of them loſt: ſo that when the ſtationer and ſeveral other perſons were preſſing to have a new edition of the former *Hiſtory of Cold*, and gave the author notice, that a good part of it was already printed off, and waited for ſome additions, that they earneſtly deſired, he had much ado to retrieve any conſiderable number of notes; moſt of which too being occaſionally written, when he could not get one exemplar to collate them with, (the ſtationer himſelf having not ſo much as one book left) it was almoſt neceſſary, that many of them ſhould be ſo written, as to be eaſily and ſmoothly joined to the titles of the formerly publiſhed hiſtory. So that the author (who at that time was much indiſpoſed) having neither health nor leiſure to put this chaos of looſe memoirs into ſome order, deſired a learned friend to take upon him the trouble of doing it for him: yet it was not poſſible, for all that ingenious perſon's care and diligence, to give a good method and ſmooth connexion to ſo confuſed an heap of particulars; all that the difficulty of the attempt permitted him to do, being to refer the particulars, as near as might be, to the reſpective titles they ſeemed moſt to belong to.

It remains, that the reader be told, whence the materials have been taken, whereof the following Appendix doth conſiſt: ſome few of them have been drawn out of printed books, becauſe cold (in itſelf, a ſubject barren enough) has been left ſo uncultivated by claſſick authors, that, according to our judicious *Verulam*'s advice, it was not thought fit to caſt away any credibly-related matter of fact, that might add to the hiſtory of it. But the greater number by far of the following particulars was taken from the relations of navigators and travellers, whom the author had the curioſity to conſult about the phænomena of cold, they had met with. And for the better gaining of ſuch informations, he became an adventurer in that, which is commonly called the *Company of Hudſon*'s *Bay*; to which thoſe that are from time to time ſent from *London*, do, either in their voyages thither and back again, or in their ſtay in that frozen country, not unfrequently meet with conſiderable, though unwelcome effects of cold. But two perſons there are above the reſt, from whoſe anſwers the author drew the conſiderableſt part of the following Appendix. One was an ingenious Engliſh phyſician, dead many years ſince, that was archiater to the then Ruſſian emperor; for whom our author having furniſhed this phyſician with ſome pleaſing, and yet effectual, chymical medicines, that were very well liked, and nobly rewarded by the Czar, the author deſired, as his recompenſe, to have ſome obſervations about cold (whereof he ſent a liſt) made in *Ruſſia*, and eſpecially at the city of *Moſcow*, where the phyſician, attending his maſter, reſided. The anſwers to Mr. *Boyle*'s queries were, by misfortune, not ſent by themſelves, but in ſeveral letters intermingled with ſo many other paſſages, relating to the Ruſſian monarch's government, religion, *&c.* that to put them in the writer's own words (which was thought the faireſt and ſureſt way to prevent miſtakes) ſome of them muſt be diſmembered from the context, and ſo muſt appear as torn and incoherent rags, and conſequently to the great diſadvantage of the papers they are made parts of. The other principal informations to be met with in this Appendix, the author received in divers conferences he procured with an ancient ſea-captain, who was looked upon as the greateſt navigator into the Northern ſeas, that has been known; upon which account his majeſty himſelf had the curioſity to ſend for him, and diſcourſe with him. This luſty old man had made above thirty ſeveral voyages into the frigid zone; and being then (as he ſtill is, if he be yet alive) in the ſervice of the company of *Hudſon*'s *Bay*, was, upon that account, the more willing, and the more free, to make anſwer to the author's queſtions, even when it required the diſcovery of his moſt ſecret obſervations. And, that this preface may not be altogether uſeleſs to the deſign of the hiſtory it belongs to, I ſhall add, on this occaſion, that the author having been viſited by the principal perſon, that ventured to winter in *Hudſon*'s *Bay* (where the ingenious captain *James*, often mentioned in the foregoing hiſtory, found it almoſt, if not quite, as rigorouſly cold, as the Hollanders found *Nova Zembla)* he was particularly inquiſitive to learn of this perſon, how he was able to ſupport the extreme rigours of the cold all the winter long: to which inquiry the navigator anſwered, that the cold was ſcarce ſufferable the firſt year he ſettled there; but that afterwards they had found an expedient to make their wintering not only tolerable, but comfortable enough. And being preſſed to name this expedient, he ingenuouſly confeſſed it to be this; that they dug ſo deep into the earth, where they thought fit to erect their wintering-houſe, that about one half of their manſion, and that part, wherein they dwelt themſelves, was built under ground; by which means the cold air could not laterally pierce into it, ſo that they ſlept warm enough, and in the day-time could keep themſelves from exceſſive cold, as long as they continued in that ſubterranean part of their houſe.

THE following papers having been ſent away to the preſs, without being reviewed by the author after the particulars, that compoſe this Appendix, were ranged in the order they now appear in; when afterwards he received them all at once as they now ſtand printed, he found (not without being troubled at it) that to comply with the deſign of referring particulars to their proper heads, ſome paſſages in this new model of them had loſt their dependencies, or the connexions they had in the papers whence they were taken. As for inſtance, the governour of *Smolenſco*, upon the borders of *Poland* and *Ruſſia*, though not here called by his own name, is mentioned as a perſon formerly nominated; which might well be done in the papers, whence this particular was extracted, becauſe he had in them, before that, been quoted by the name of Lieutenant-General *Drummond*. Nor is this (it is feared) the only paſſage, wherein the almoſt neceſſary diſlocation of particulars, that before had a manifeſt connexion, may need the reader's pardon, which is therefore begged by the author; who yet hopes, that theſe paſſages will not be found numerous, and that an attentive reader will, by circumſtances, eaſily enough diſcern what things are his own, and thoſe comparatively few, that might have been more expreſly delivered, as received from others. This inconvenience was not eſpied, till it was too late to prevent it.

SOME few particulars in the following Appendix may perhaps be found coincident, as to the main, with ſome paſſages of the book it is annexed to, and yet differing in ſome circumſtances. But theſe the author thought it candid not to ſuppreſs, becauſe in hiſtorical matters truth is the thing, that is to be principally regarded: beſides, that in theſe points, wherein the relations of the hiſtory and of the Appendix agree, they will mutually confirm each other, (which in matters, whereof few trials or obſervations are yet extant, is a thing of no ſmall moment) and thoſe circumſtances, that may ſuggeſt limitations or cautions, may be of good uſe in the *Philoſophick Hiſtory of Cold*, and engage the curious to make a farther ſearch by heedful and repeated trials.

The author had divers other papers, that might have enriched the preſent Appendix, if the confuſion, that was occaſioned among his manuſcripts, by a ſudden fire, that obliged him very haſtily to remove them after midnight, had not ſuppreſſed them, (and which he hath elſewhere complained of, as very prejudicial to him in reference to other tracts) at leaſt till another opportunity. But without the proſpect of a larger appendix, the printer wanted not encouragement to preſs for a ſecond edition, by the favourable reception, that was given to the firſt by divers learned men, not only at home but abroad: where Monſieur *Du Hamel*, famous for many curious and elaborate pieces, in one of his learned treatiſes, gives this character of the foregoing hiſtory: *Cum anno ſuperiore inciderim in librum de frigoris hiſtoria, ab illuſtri & doctiſſimo viro D.* Boyle *compoſitum, quo argumentum, à philoſophis penè intactum, tam diligenter & eruditè pertractavit, ut vix quicquam accuratius ſperari poſſit. Du Hamel Corp. Aff. Cap. de Frigore.* And ſince him an ingenious doctor of phyſick, (that in a cold climate has written, though not copiouſly, yet learnedly and *ex profeſſo*, of *cold)* ſpeaks thus of our author and of his hiſtory: *Agmen hoc eruditum* (having ſpoken before of the chief authors, that have written about *cold) claudat Dominus* Boyle, *delicium & ornamentum noſtri temporis, cui jam nunc omnem noſtram attentionem renovare æquum eſt. Non enim aliam ob cauſam hoc loco ultimo eum amplectendum nobis ſervavi, quàm ut veluti per compendium, liberiori tamen paulò excurſione factâ, & ſepoſito nonnihil capitum præcedentium ordine, tum ea, quæ jam partim allata fuere, tum quæ dicenda adhuc reſtant, ſine tædio & concinnâ brevitate, ejus quaſi ductu, quem toto hoc lubrico & glaciali itinere ducem mihi propoſui, examini ulteriori ſubjicerem.* Conradi Diſſertat. Medico-phyſ. de Frigoris Natura & Effectibus, *page* 51.

These juſt elogies of our honourable author (to omit many others) are here inſerted, not to grate on his modeſty by the repetition of his own (tho' merited) praiſe, but as incitements to the ſtudious to peruſe his philoſophy, with the principles thereof, contained in this and his other tracts, (which in many things differ from thoſe of the *Peripatus*, the *Academia*, and the *Stoa* too) in regard they have already paſſed the teſt of the learned both at home, and alſo beyond the ſeas. For though, as an ingenious writer ſpeaks in another caſe, little heed is to be given to the gale of a private man's fancy, yet it is conſiderable, when the wind blows from all quarters. The univerſal approbation, which the labours of our author have met with, requires an high veneration for, and medullary ſearch into, his writings. It was the ſaying of an ancient rhetor, in reference to oratory, *Ille ſe multùm profeciſſe ſciat, cui* Cicero *valde placuerit*; which may be applied with as much veracity to Mr. *Boyle*, whoſe philoſophical lucubrations about the ſubjects he is pleaſed to ventilate and diſcuſs, are the top of their kind. Therein the *Initiati* may find great encouragement for their progreſſion, and alſo thoſe, who are more experienced, and ſit but one form below the *Adepti*, may count it no diſparagement to learn of him, whoſe diſquiſitions have been ſo inſtructive to the learned world.

## *An* ADVERTISEMENT.

THAT the reader may not wonder to find the following dialogue cited in the *Hiſtory of Cold*, whereunto nevertheleſs it is ſubjoined; he is to be informed, that a ſection about *Antiperiſtaſis* was really both written and tranſcribed before any part of that hiſtory was ſent to the preſs. But finding, that the acceſſion of new particulars had ſo much ſwelled it, that it was unfit to paſs (as I firſt deſigned it ſhould) for one of the titles of the *Hiſtory of Cold*, I judged it convenient to ſever it from the reſt, upon the ſcore of its bulk, and yet annex it to them upon the account of thoſe many hiſtorical paſſages in it, that belong to the ſame ſubject, that is handled in thoſe ſections. The reader will quickly find, that the tract conſiſts of two parts, whereof the firſt (which to allow the more freedom of inquiry and diſcourſe, is written in the way of dialogue) contains an *Examen* of *Antiperiſtaſis*, without pretending to queſtion it abſolutely and indefinitely, but rather, as it is wont to be taught and proved. And this dialogue, for reaſons, that it too little concerns the reader to know, and would take up too much time to tell him, both begins as a continuation of ſome former diſcourſe, and ſomewhere mentions the author, as a third or abſent perſon. And to make it the more like to other dialogues, the quotations are not made with the author's punctualneſs in the reſt of this book, but yet with his uſual faithfulneſs; nor hath his introducing men diſcourſing (as it were by chance) kept him from putting into the margin the very words of ſome paſſages, which he thought the moſt important and likely to be diſtruſted. But though this firſt part be entire and finiſhed in its kind, and ſo might very well (if not beſt) have been put forth ſingle, to invalidate the common doctrine of *Antiperiſtaſis*, (in the ſenſe wherein it is there oppoſed) yet becauſe in philoſophical matters, it is not ſo much victory or applauſe, that is to be ſought, as truth; I forbore not to ſubjoin to a diſcourſe, that may perchance ſatisfy moſt of my readers, ſome ſcruples, about which I wiſhed for further ſatisfaction and certainty my ſelf; of the chiefeſt of which, the ſceptical conſideration will give the reader an account.

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## *The Publiſher to the ingenious Reader.*

I AM fully perſuaded, you will much rejoice to ſee that exquiſite ſearcher of nature, the illuſtrious *Robert Boyle*, come abroad again, as knowing he never does ſo, but when richly furniſhed with very inſtructive and uſeful matter. He preſents you here with a treatiſe of *New Obſervations and Experiments, in order to an Experimental Hiſtory of Cold*. This is the body of the book; but it comes accompanied with ſome Preliminaries, and an Appendix, whereof the former contains *New Thermometrical Experiments and Thoughts*, the latter an *Exercitation* about the *Doctrine of Antiperiſtaſis*, followed with a ſhort *Examen of Mr.* Hobbes*'s Doctrine, touching Cold.* From all which it will more and more become manifeſt, with what ſpirit and care this excellent perſon advanceth real philoſophy; with what exactneſs he purſueth his engagement therein; and how great caution he uſeth, that nothing may ſlide into the philoſophical ſtore, that may prove prejudicial to the axioms and theories hereafter perhaps to be deduced from thence.

Having thus ſhortly given you my ſenſe of the ſubſtance of this conſiderable treatiſe, I am now to advertiſe you of one or two circumſtances, neceſſary to be taken notice of in its peruſal.

One is, that the noble author being at *Oxford*, when the book was printed at *London*, he hopes the reader will not impute to him the errors of the preſs, which yet he is perſuaded will not be many, and out of which muſt be excepted a blank or two, occaſioned by this, that the author's papers being near two years ſince given to be tranſcribed to one, whoſe ſkill in writing was much greater, than (as it afterwards appeared) his knowledge of what was, or was not good ſenſe, or true Engliſh; this perſon ſuddenly going for *Africk* before the tranſcript had been examined, and not taking care to leave all the firſt copy, the author found, (beſides ſeveral blanks, that he filled up out of his memory, or by repeating the experiments, they belonged to) one or two, where he was not able to repair the copiſt's omiſſions: and beſides unexpectedly met with very many paſſages ſo miſerably handled, that by putting him to the trouble of writing almoſt a new book, when part of this was already in the preſs, it much retarded the publication of that, which now comes forth.

The other is, that, whereas in the preface ſome paſſages are ſo penned, as to ſuppoſe the book to be publiſhed early in the winter, the reader is to be advertiſed, that the former part of this preface was ſent a good while ſince to the preſs, though the latter, however then written out, was hindered from accompanying it, by ſome hopes of the author's to gain by delay an opportunity (he miſſed of) to perfect an experiment he was deſirous to inſert; and that, when the froſt began, which was late in the ſeaſon, the coldneſs did within a while arrive at that degree, that by its operation upon the moiſtened paper, it long put a ſtop to the proceedings of the preſs. But the author, that he might neither be quite defeated of his aim, nor diſappoint the curious of their expectation, did in the firſt or ſecond week of the froſt, which was about the end of the year 1664, preſent the Royal Society with divers copies of the *Hiſtory of Cold*, though the book were not then quite printed off. And theſe books being ſo near finiſhed, that of twenty-one ſections, whereof the *Hiſtory of Cold* conſiſts, the preſs had then reached to about the 19th, and I had the 20th in my hands to ſupply it, when the weather ſhould permit; the author hoped, that by ſeaſonably communicating ſo much of his intended treatiſe to ſo many of the Virtuoſi, that were the likelieſt to make uſe of it, he had pretty well provided againſt the prejudice, that might otherwiſe accrue from the ſlowneſs of the preſs, and therefore allowed himſelf to ſubjoin to the hiſtory, the diſcourſe of *Antiperiſtaſis*, and the *Examen* of Mr. *Hobbes*'s doctrine*, as belonging to the ſame ſubject. And finding the froſty weather to continue later than was expected, (which had he foreſeen, before his hiſtory was printed off, it would have given him opportunity of enlargements) he hopes the publication may not be yet too late for diligent readers, to make ſome uſe of the ſeaſon for examining his experiments, or trying ſome of the new ones, thoſe may ſuggeſt. And therefore for the quicker diſpatch of the book, he purpoſely omits, and reſerves for another occaſion, beſides the papers, that he hath not yet given me, ſome that I have already in my hands. And it is, I preſume, for the ſame reaſon, that he forbears to publiſh, what he long ſince writ about the origin of forms and qualities, in a ſmall tract, which he had thoughts of ſending forth in the company of the enſuing hiſtory, as a diſcourſe fit to be an introduction as well to that, as to his hiſtorical writings about colour and ſome other qualities.

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* It was thought needleſs to inſert Mr. *Hobbes*'s ſcheme touching this ſubject, becauſe it only ſhews, that wind is the cauſe of cold.

This is all the advertiſement I had to give you. And ſeeing it would be altogether impertinent, for me to take any pains, or to uſe any art to procure a guſt for a book, compoſed by Mr. *Boyle*, I have no more to ſay, but that the author being ſo generous as to oblige foreign nations as well as his own, has already taken care of having it put into Latin. Farewel.

London, March
10, 1664-5.

*H. O.*

## *The Author's Preface Introductory.*

COLD is ſo barren a ſubject, and affords ſo few experiments, that are either very delightful for their ſurpriſing prettineſs, or very conſiderable for their immediate uſe, that inſtead of admiring, that any of my friends ſhould wonder at my having been induced to write of ſuch a theme, I freely confeſs, that I have been ſometimes tempted to wonder at it my ſelf; and therefore I think my ſelf obliged to give my readers an account of theſe three things; Why I thought fit to write of cold at all? For what reaſons I have treated of it after the manner to be met with in the enſuing book? and, Why I venture my unfiniſhed collections about it, abroad ſo ſoon?

I. To ſatisfy the firſt of theſe queries, I have ſeveral of theſe things to ſay.

And firſt, that the ſubject I have choſen is very noble, and important; for ſince heat has ſo general an intereſt in the productions of nature's phænomena, that (motion excepted, of which it is a kind) there is ſcarce any thing in nature, whoſe efficacy is ſo great, and ſo diffuſed, it ſeems not likely, that its antagoniſt, cold, ſhould be a deſpicable quality. And certainly cold, and heat, eſpecially when employed by turns, are the two grand inſtruments, by which nature performs ſo many of her operations here below, that our great *Verulam* did not ſpeak inconſiderately, when he called heat the right hand of nature, and cold her left: and though in our temperate climate the effects of cold ſeem not to be very remarkable, yet beſides that in more northern regions they are oftentimes ſtupendous, the nature of that quality muſt needs be very well worth our conſidering, if it were but for the power it has to moderate and check the operations of heat; upon which account alone, if there were no other, it may be looked upon as ſo conſiderable a quality, that even leſſer diſcoveries about it may both be acceptable and prove uſeful.

In the next place I ſhall repreſent, that notwithſtanding cold's being ſo important a ſubject, it has hitherto been almoſt totally neglected. For I remember not, that any of the Claſſick authors, I am acquainted with, have ſaid any thing of it, that is conſiderable. They do indeed generally treat of it, as one of the four firſt qualities. But that, which they are wont to ſay, amounts to little more, than that it is a quality, that does congregate both things of like and unlike nature; the unſatisfactorineſs of which vulgar definition I had ſome years ago an occaſion to manifeſt (in another treatiſe, the *Sceptical Chymiſt)*: and having given us this inconſiderate deſcription of cold, they commonly take leave of the ſubject, as if it deſerved no further handling, than could be afforded it in a few lines, wherein indeed they ſay too much about it, but not enough. And even among other writers of bodies of natural philoſophy, or of the doctrine of meteors itſelf, the reader will find, how little of true and pertinent has been contributed to the enſuing *Hiſtory of Cold*. And though among the vulgar, and the writers, that adopt their traditions without examining them, I find ſome few particulars delivered touching cold; yet ſome of them are ſo untrue, and others ſo uncertain, that they have furniſhed me with little elſe, than the neceſſity of queſtioning, or of diſproving them: ſo that when I conſidered all theſe things, I could not but take notice, that very little hath hitherto been ſaid of cold, by thoſe ſchoolmen, and other writers, (that I have yet met with) who have profeſſedly (though but perfunctorily, and, as it were, incidentally) treated of it. But yet inſtead of thinking it a diſcouragement, that ſo many learned men, to whom that quality could not but be obvious, and to whom it was as familiar as to me, had in ſo many ages ſaid little or nothing of it to the purpoſe; I found this very thing an invitation to my attempt, that I might in ſome meaſure repair the omiſſions of mankind's curioſity towards a ſubject ſo conſiderable, and ſo diffuſed, by trying what I could do toward founding the hiſtory of a quality, which has been hitherto ſo neglected, as if all men judged it either unworthy of being cultivated, or uncapable to be improved.

Another inducement to me was, that having ſix or ſeven years ago written ſome tracts (though I have not ſince had opportunity to publiſh them) in order to the Hiſtory of *Heat* and *Flame*; it ſeemed the more proper for me to treat of the contrary quality, *Cold*; ſince, according to the known rule, confronted oppoſites give themſelves a mutual illuſtration. And another inducement of almoſt the ſame nature was afforded me by remembering, that whereas cold, in its higher degrees, is wont to be communicated to us by the air (whenceſoever the air has it) and I have on ſeveral occaſions been obliged to treat of divers properties of the air, as of its weight and ſpring (in my *Phyſico-Mechanical Treatiſe)* of the ſeveral ſtrengths of that ſpring, in proportion to the degrees of the air's condenſation; the experiments of which, reduced into tables, were firſt publiſhed (and for aught I yet know made) by us, (in the defence of that book againſt *Franciſcus Linus*, chapter the fifth of that treatiſe), and of divers other qualities of the air in ſeveral paſſages of our other writings, which it were now ſuperfluous to take notice of; all this made it appear convenient enough, that among other attributes of the air, which we either have had, or expect to have occaſion to treat of, ſo eminent and diffuſed a one as its coldneſs ſhould not be left untouched by the ſame pen.

But though neither any, nor all theſe inducements had been ſufficient to engage me to draw together, and recruit my obſervations concerning cold, there was another, that could not miſs of prevailing, the command of the Royal Society, impoſed on me in ſuch a way, that I thought, it would leſs miſbecome me to obey it unſkilfully, than not at all. Eſpecially ſince from ſo illuſtrious a company (where I have the happineſs not to be hated) I may in my endeavours to obey and ſerve them, hope to find my failings both pardoned, and made occaſions of diſcovering the truths, I aimed at.

II. After this account of the motives, that induced me to reſolve to draw together the notes I had on ſeveral occaſions ſet down, about the phænomena of cold, it may be now expected, that I render ſome reaſon, why I have thus digeſted them, and why I have not written the following treatiſe in a more accurate way.

First, then I readily acknowledge, that the method is not exact. Nay, that it is leſs ſo than the ſcheme of heads of inquiry, that I drew up, to give myſelf a general proſpect of the ſubject I was to handle. But when I had conſidered, how comprehenſive a theme I had pitched upon, and how much more comprehenſive, future diſcoveries and hints might make it, I thought it altogether unadviſeable for me, that had no more time, nor no more opportunity than I had, when I begun to compile the following hiſtory, to engage my ſelf to a method, according to which I was not perhaps able to treat of any one of the principal parts of the deſigned hiſtory. And yet, on the other ſide, being unwilling to huddle my experiments confuſedly together, I thought it an expedient, that might in great part decline both thoſe inconveniencies, to draw up a company of comprehenſive titles, under which might commodiouſly be ranged moſt of the particulars I had obſerved, reſerving thoſe few, that were not ſo eaſily referrible to any of thoſe, to be thrown at laſt into a ſection by themſelves. And this I the rather did, becauſe I would not, by a confinement to a ſtrict method, diſcourage others from continuing the hiſtory, by adding new titles to thoſe twenty-one, I have treated of, as well as by inſerting other experiments or obſervations in any of them.

That the ſections or titles are very unequal, will not, I preſume, be much blamed by them, that conſider, that my deſign being to ſet down matters of fact, not write a complete and regular treatiſe, the length of each ſection was to be determined, not by its proportion to that which went before it, or followed after it, but by the number and condition of the particulars, that were to compoſe it. And I thought it much more pardonable, that any of the ſections ſhould be diſproportionately ſhort, than lengthened either by untruths or by impertinencies.

Some of the accounts will probably to ſome readers appear too prolix; and I could very eaſily, as well as willingly, have prevented that objection, if I had not more conſulted the ſcope of the book, than the eaſe or reputation of the writer. But my deſign being, not only to gratify ſome readers, but to aſſiſt others to proſecute the work I had begun, as the experiments are moſt of them new, and many of them tried by methods hitherto unpractiſed; I conceived my ſelf obliged to ſet down ſomewhat circumſtantially, not only the events, but the manner of my trials, that I might at once, both the better ſatisfy the ſcrupulous, and be aſſiſtant to thoſe, that would examine or repeat ſuch experiments, and alſo gratify thoſe, who are pleaſed to think, that a ſomewhat aſſiduous converſation with nature may have given me ſome little faculty in deviſing experiments, and the ways of making them, above thoſe, that have been converſant only with books and notions. And in ſome of the following trials I was the more induced to ſet down all the principal circumſtances, becauſe that being not to be made, but by the help of glaſſes ſkilfully ſhaped, and hermetically ſealed, and other inſtruments and operations, that require more tools, and more of manual dexterity, than every ingenious man is maſter of; it is very likely, that moſt readers will not be able, or perhaps willing, to reiterate ſuch trials, and therefore will be glad to find them ſo delivered, as that they may without too much danger acquieſce in them, as being made with diligence as well as faithfulneſs. The latter of which qualities will, I preſume, be allowed me, as well upon the account of the plain and ſimple way, wherein matters of fact are delivered in the following book, as upon the ſcore of the teſtimonies, that even adverſaries, as well as others, have thought fit to give to the hiſtorical part of my former treatiſes. And (to intimate that on this occaſion) this ſtrict fidelity to truth I ſcruple not to own, though perhaps it may be attended with an inconvenience in point of reputation, that writers of leſs veracity are expoſed to. For I have found by experience, that ſome men, who probably would not mention the experiments of moſt others, without vouching their authors, for fear of loſing their own credit, in caſe the thing related ſhould not prove true, have, without taking the leaſt notice of me, made uſe of ſuch experiments of mine, as I have ſtrong motives to think they never made nor ſaw, only becauſe they had been related by one, after whom they thought they might without a hazard of their credit deliver any matter of fact. And the liberty, that ſome have allowed themſelves in adopting my communications (ſuch as they are) is notorious enough to have been publickly complained of more than once, by perſons, that are meer ſtrangers to me. But though I had not the probability, which the notice, that begins to be taken of it, ſeems to give me, of having ſome juſtice done me; yet veracity is a quality, that does, I think, ſo well become a Chriſtian and a writer of natural hiſtory, that I had much rather undergo any diſadvantage, I may be ſubject to for it, than decline the practice of it. But to return to the following hiſtory.

I CONFESS the prolixity of ſome paſſages of our hiſtory is increaſed by the tranſitions, excuſes, and ſuſpicions, that are made uſe of in them; but I confeſs too, that if this way of writing be a fault, it was not always cauſed by inadvertency. For as to what is ſaid to connect the parts of our hiſtory together, or excuſe the not proſecuting of this or that particular trial, the heedful reader may oftentimes perceive, that they contain in them, though not perhaps conſpicuouſly, either cautions, or advertiſements, or hints, not impertinent to my main ſcope, and improveable by an attentive peruſer. And as for the ſuſpicions and ſcruples, to which now and then I may ſeem to have too long indulged, I had two or three inducements to invite me to what I did. For the mention of conjectures, that every reader was not ſo likely to light upon, might more conduce, than at firſt one would think, to the main deſign of my book, which was to begin, and promote the natural hiſtory of cold; ſince theſe ſuſpicions about the cauſes and ſcruples about other things, relating to our experiments, may probably produce, not only new reaſonings and inquiries, but new trials, to clear the difficulties, and determine the doubts. Beſides, I thought it not amiſs to take ſuch occaſions to make ſome readers ſenſible, that to make indubitable inferences even from certain experiments is not near ſo eaſy a work, as many are pleaſed to imagine. And whereas I was not without inducements to think, that ſome critical and ſagacious readers will not only excuſe my having taken notice of ſo many ſcruples, but wiſh I had moved more on ſome occaſions, and propoſed ſome in certain caſes, where I have not mentioned any, I thought it might invite ſuch jealous readers to think, that I foreſaw divers little difficulties and ſcruples, that might be moved in ſeveral caſes, where I have not expreſly taken notice of them, either becauſe I judged them eaſy enough to be anſwered without my help, or becauſe the things themſelves were not conſiderable enough to deſerve a long or ſollicitous diſcourſe to clear them, eſpecially from a writer, that being often tired himſelf in examining ſuch niceties, was afraid he ſhould too much tire the generality of his readers, if he ſhould too frequently inſiſt upon them.

IF it be objected, that notwithſtanding ſome things are ſet down prolixly, yet other experiments, that might properly be referred to ſome of the titles I handle, are wholly omitted; I anſwer, that this were indeed a fault in one, that ſhould pretend to write full and accurate diſcourſes of the ſubjects propoſed in his titles, but not in me; who do not at all pretend to ſay, under each head, all that may be pertinently referred to it, (for that may probably be a great deal more, than is yet come to my knowledge) but only thoſe particulars, that I myſelf have tried or obſerved, or at leaſt have received upon credible teſtimony. And, perhaps, ſome amends may be made for theſe omiſſions, by my having frequently enough mentioned the experiments, that, when I propoſed them, I had only deſigned or attempted without perfecting them. For the experience of many ages has ſhewn us, that hitherto, not only men do not appear to have made any ſtore of trials concerning cold, but ſeem not to have ſo much as deſigned it. And therefore it ſeemed not unreaſonable to preſume, that it

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I CONFESS the prolixity of ſome paſſages of our hiſtory is increaſed by the tranſitions, excuſes, and ſuſpicions, that are made uſe of in them; but I confeſs too, that if this way of writing be a fault, it was not always cauſed by inadvertency. For as to what is ſaid to connect the parts of our hiſtory together, or excuſe the not proſecuting of this or that particular trial, the heedful reader may oftentimes perceive, that they contain in them, though not perhaps conſpicuouſly, either cautions, or advertiſements, or hints, not impertinent to my main ſcope, and improveable by an attentive peruſer. And as for the ſuſpicions and ſcruples, to which now and then I may ſeem to have too long indulged, I had two or three inducements to invite me to what I did. For the mention of conjectures, that every reader was not ſo likely to light upon, might more conduce, than at firſt one would think, to the main deſign of my book, which was to begin, and promote the natural hiſtory of cold; ſince theſe ſuſpicions about the cauſes and ſcruples about other things, relating to our experiments, may probably produce, not only new reaſonings and inquiries, but new trials, to clear the difficulties, and determine the doubts. Beſides, I thought it not amiſs to take ſuch occaſions to make ſome readers ſenſible, that to make indubitable inferences even from certain experiments is not near ſo eaſy a work, as many are pleaſed to imagine. And whereas I was not without inducements to think, that ſome critical and ſagacious readers will not only excuſe my having taken notice of ſo many ſcruples, but wiſh I had moved more on ſome occaſions, and propoſed ſome in certain caſes, where I have not mentioned any, I thought it might invite ſuch jealous readers to think, that I foreſaw divers little difficulties and ſcruples, that might be moved in ſeveral caſes, where I have not expreſly taken notice of them, either becauſe I judged them eaſy enough to be anſwered without my help, or becauſe the things themſelves were not conſiderable enough to deſerve a long or ſollicitous diſcourſe to clear them, eſpecially from a writer, that being often tired himſelf in examining ſuch niceties, was afraid he ſhould too much tire the generality of his readers, if he ſhould too frequently inſiſt upon them.

IF it be objected, that notwithſtanding ſome things are ſet down prolixly, yet other experiments, that might properly be referred to ſome of the titles I handle, are wholly omitted; I anſwer, that this were indeed a fault in one, that ſhould pretend to write full and accurate diſcourſes of the ſubjects propoſed in his titles, but not in me; who do not at all pretend to ſay, under each head, all that may be pertinently referred to it, (for that may probably be a great deal more, than is yet come to my knowledge) but only thoſe particulars, that I myſelf have tried or obſerved, or at leaſt have received upon credible teſtimony. And, perhaps, ſome amends may be made for theſe omiſſions, by my having frequently enough mentioned the experiments, that, when I propoſed them, I had only deſigned or attempted without perfecting them. For the experience of many ages has ſhewn us, that hitherto, not only men do not appear to have made any ſtore of trials concerning cold, but ſeem not to have ſo much as deſigned it. And therefore it ſeemed not unreaſonable to preſume, that it would prove an aſſiſtance to the generality of readers, if probable and practicable experiments were propoſed to them. And ſince it is the improvement of the ſubject that I aim at, by whomſoever it may happen to be improved, I thought it but reaſonable to uſe my endeavour, that thoſe experiments, which for want of opportunity I myſelf could not try, might be tried by others, who may be befriended by more favourable circumſtances. Nor is that great ornament and guide of philoſophical hiſtorians of nature, the Lord *Verulam* himſelf, aſhamed to ſubſtitute, on I know not how many occaſions, his *fiat experimentum*; that is, a precept or a wiſh to have an experiment made, inſtead of an account of the experiment made already. And yet in this mention of things, I could wiſh to have tried, I have been far more ſparing than every reader will take notice of. For I judged it not diſcreet to mention all the experiments I had thought upon, or even already ſet down in ſeveral catalogues, leſt they ſhould appear extravagant to thoſe, that are unacquainted with the ſeveral notions, and trials, and contrivances, which made them appear to me not irrational, and which yet it would have been tedious, and not worth while to have particularly mentioned.

But that in what we have newly (and a little before) had occaſion to ſay of our ways of making experiments, our meaning may not be miſconſtrued, we muſt here advertiſe the reader, that though, in many of the following experiments, the contrivances will not, perchance, be diſliked, yet in many others, they are far enough from being ſuch, as might have been propoſed by one, that had wanted no accommodations fit for ſuch a work as ours. But I was reduced to make many of thoſe experiments in a village; and whilſt I was writing them, was obliged to make frequent removes, by which means I ſeldom had the liberty to make my trials after ſuch a manner, as I could contrive them, if I could have inſtruments and other aſſiſtance to my wiſh. For ſometimes I wanted conveniently-ſhaped glaſſes; ſometimes the implements neceſſary to ſeal them up with; ſometimes ſuch ingredients, as I needed to work on; oftentimes froſty weather, for the freezing of bodies to be expoſed to the open air, and not ſeldom ice and ſnow for artificial congelations; ſometimes weather-glaſſes, eſpecially ſealed ones, two of which being unluckily broken after one another, kept me from being able to make divers conſiderable experiments; ſometimes tender ſcales, and ſometimes other mechanical inſtruments of ſeveral ſorts, and more than ſometimes (for it happened very frequently) I wanted time ſo to proſecute and finiſh the experiments, as to ſatisfy myſelf about divers circumſtances, which, though poſſibly few readers will take notice to be wanting, I would gladly have obſerved, if I had not been hindered, not only by the haſte I was often fain to make for fear of loſing a froſt, but the importunities both of other avocations, and even of the diſtraction given me by the multitude of experiments, which haſte made me proſecute at once. And indeed, as in divers others of the treatiſes, I have occaſionally written, ſo particularly in a great part of this *Hiſtory of Cold*, my writing in places, where I wanted ſuch mechanical accommodations, as I could have wiſhed for, and deviſed, has reduced me oftentimes both to leave experiments untried, that would have much illuſtrated my ſubject, or cleared the difficulties of it, and contrive ſeveral of thoſe I mention, not after the beſt manner that might be, but after the beſt manner, that was practicable by the accommodations I was then able to procure: ſo that it need not be wondered at, or blamed, if in ſome paſſages of theſe papers, experiments to the ſelf-ſame purpoſe are more accurately tried, or by more expedient ways at one time than another. For as a phyſician, if he come to practiſe in the country, where apothecaries ſhops are but ill furniſhed, both as to the number and as to the quality of the drugs, muſt accommodate his practice to the ſcant *materia medica*, of which alone he has the command: ſo when I write of experimental matters, in places where I cannot have workmen, nor inſtruments fit for my turn, I muſt be content to vary my experiments accordingly, and ſuit them to the accommodations I am confined to; which, though it be an unwelcome condition, is made the leſs ſo to me, by a hope, that the equitable readers will think it to be all, that a man is bound to do in ſuch caſes, to procure the beſt aſſiſtances he can, and manage thoſe, he is able to procure, to the beſt advantage.

AND this I rather take notice of on this occaſion, that ingenious men might not be too much diſcouraged by imagining, that, becauſe they live in the country, or upon other ſcores, cannot furniſh themſelves with the beſt inſtruments and accommodations, nor enjoy the aſſiſtance of the ſkilfulleſt artificers, they are either unqualified for the making of experiments and obſervations, or ſuperſeded from it. For though, in ſome caſes, where the meaſures of things muſt be nicely determined, and principally in obſervations, whereon either theorems or hypotheſes about the proportions of things are to be grounded, very good inſtruments are exceeding uſeful, and ſometimes neceſſary; yet there are thouſands of particulars, whoſe knowledge may be inſtructive to thoſe, that are or would be Naturaliſts, where no ſuch nicety is requiſite, and where the meaſuring things by ounces and inches will ſerve the turn, without determining them to lines, and grains. And even in caſes, where exact obſervations are (to ſome purpoſes) requiſite, thoſe, that are not ſo, may be oftentimes very uſeful, by affording hints, by which others may be excited and aſſiſted to make thoſe more accurate trials. And here let me take notice, that a tool or inſtrument is not therefore to be deſpiſed, if it be proper enough to the particular uſe, to which it is applied, becauſe ſome more mechanical head or hand may propoſe or make another, that is more artificially contrived, or more neat and portable, or that will alſo perform other things, than that we are ſpeaking of. For there is a vaſt multitude of phyſical phænomena, wherein mathematical exactneſs is not neceſſary, and obſervations about theſe may be well enough made by divers other ways, than by the moſt artificial, that can be deviſed. As though a fine watch may have theſe advantages, that it is a neater thing, and more portable than an ordinary clock; that it may be improved by the addition of an alarum, and that it may alſo, perhaps, ſhew the day of the month, the age of the moon, the tides, and divers other things, of which the clock ſhews not any: yet an ordinary clock may ſerve to meaſure an hour by, as well as this finer engine; and ſo may a ſun-dial, and many other inſtruments on divers occaſions; though in other caſes, and other regards, they be far leſs commodious, than either a watch or clock. Beſides, that in many caſes a ſkilful Naturaliſt will, by a variety and collation of experiments, make the ſame diſcoveries, and perform the ſame things, for which others be wont to be beholden to inſtruments, and perhaps do many things without them, that have never been done with them. And ſince neceſſity is proverbially allowed to be the mother of inventions, even in tradeſmen, and vulgar heads, why ſhould we doubt, but that the rich and inventive intellect of a philoſopher may, in caſes of neceſſity, turn itſelf, and contrive the things it can diſpoſe of, into ſo many differing forms, that it will often make its own ſagacity and induſtry ſupply the want of exact tools and inſtruments? And theſe conſiderations, that tend to keep ingenious men from deſpondency, I therefore think fit to inculcate, becauſe the commonwealth of learning would loſe too many uſeful obſervations and experiments, and the hiſtory of nature would make too ſlow a progreſs, if it were preſumed, that none but geometers and mechanicians ſhould employ themſelves about writing any part of that hiſtory.

But to return to thoſe trials of our own, that occaſioned this (as I hope, ſeaſonable) digreſſion, I was about to add, that as the acknowledgment I was making, that ſome of the trials were, for want of accommodations, leſs artificial than I could have deſigned or wiſhed them, touches not all, nor haply the greateſt part of the following experiments; ſo it need not derogate from the readers reliance on thoſe, which it does concern. For though ſome of them might have been more artificially performed to the manner, yet they could not have been more faithfully regiſtered, as to the events. Which though I dare promiſe myſelf, that moſt readers will be induced to believe, upon the conſiderations not long ſince intimated; yet I think it requiſite to give this intimation on this occaſion, becauſe, that though I have (in the two eſſays of the *Unſucceſsfulneſs of Experiments)* largely manifeſted to what contingencies divers experiments are liable, yet I have found very few, whoſe events are ſo ſubject to be varied, by ſlight and not eaſily heeded circumſtances, as ſeveral experiments concerning cold; where oftentimes the degree of that quality, or the time during which it continues applied, or the manner of application, or the thickneſs, ſhape and bulk, *&c.* of the veſſels, that contained the matter expoſed to it, may have a far greater influence on the ſucceſs, than thoſe, that have not tried, can eaſily imagine. And it increaſes the difficulty, that theſe experiments of ours being (very few excepted) the only, that are yet made publick concerning cold; we cannot ſo eaſily, as in other caſes, free ourſelves from the doubts, that may be ſuggeſted by different events, by comparing together ſeveral experiments of the ſame kind; though to obviate this inconvenience, as far as I may, I have divers times in caſes, where the experiments ſeemed like to be thought ſtrange, or to be diſtruſted, ſet down ſeveral trials of the ſame thing, that they might naturally ſupport and confirm one another.

Of thoſe contingent experiments about cold, I was newly ſpeaking of, the reader may meet with an eminent example in the 21ſt title, where mention is made of the differing effects of air blown out of a pair of bellows upon a weather-glaſs: and as for the ſuſpicion I there conclude with, (though I yet doubt, whether it will reach all the caſes incident to that experiment) I have ſince been confirmed in it, by finding, that by purpoſely varying the tempers of the bellows themſelves, I could divers times conſiderably vary the operations, which the winds, blown out of them in their differing ſtates, had upon the liquor in the weather-glaſs *. Of this I expect to have an opportunity of ſaying more, and therefore ſhall at preſent add but this one particular, which may ſufficiently juſtify me for having ſaid, that weather-glaſſes and our ſenſories may give very differing informations about the temperature of the air turned into wind, by being blown out of the ſame pair of bellows. For having taken two hermetically-ſealed weather-glaſſes furniſhed with highly rectified ſpirit of wine, and purpoſely made for my experiments by a perſon eminently dextrous in making ſuch inſtruments, and having likewiſe provided a large pair of bellows, I found, that by blowing twenty blaſts at a time on the ball of one of them, though the pipe were not only ſlender, but of an unuſual length, amounting to about thirty inches, yet the liquor did not ſenſibly ſubſide any more than riſe. And in the other weather-glaſs, whoſe pipe was leſs long, but whoſe ball was purpoſely made far greater to be the fitter for ſhort and nice experiments, we found more than once, (and that as well in the cold air, as in a cloſe room) that the wind, that was blown in divers blaſts out of the bellows againſt the lower part of the inſtrument, did not only make the ſpirit of wine ſubſide, but did make it manifeſtly, though but very little, aſcend. And it is not neceſſary for the making good of what I taught, that ſuch trials ſhould always ſucceed juſt as theſe did, ſince it may ſuffice to prove what I pretended, that a good ſealed weather-glaſs did divers times diſcover the wind to be rather warm, than cold, when upon trial (then purpoſely made) it felt not only manifeſtly, but conſiderably cold, both to a by-ſtander's hand, and to my own hand and face, though my hand, that was blown upon, were immediately before more than ordinarily cold.

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* Another remarkable inſtance of the variable ſucceſs of the experiments of cold I have met with in an experiment of the learned Dr. *Merret's*, about the congealing of oil of vitriol. For though I expoſed that liquor in ſmall veſſels of differing ſizes and ſhapes, and even in ſlender glaſs pipes, ſealed but at one end, yet neither the cold of the air in froſty nights, that were extraordinarily ſharp, nor, which is more, our frigorick mixture of ice and ſalt, would make the experiment ſucceed; notwithſtanding that we tried it with ſeveral parcels of oil of vitriol. And yet, that the learned doctor by the help of the air alone (for he uſes not our frigorick mixture) did bring that liquor, either to a true congelation, or a coagulated ſubſtance, that looked juſt like ice, both ſome eminent Virtuoſi, and I my ſelf, who had the curioſity to examine it, can bear him witneſs.

And I ſhall here add, that judging it fit to make further trial with an unſealed weather-glaſs, I made one, that was in ſome regards preferable to thoſe mentioned in the ſecond preliminary diſcourſe, by making the bubble large, and the cylindrical pipe ſo proportioned to it, that inſtead of a drop of water, a pillar about an inch long of that liquor was kept ſuſpended, and played as well conſpicuouſly as nimbly up and down in the pipe: and having faſtened this inſtrument in an erected poſture, with the ſpherical part uppermoſt, to the inſide of a window, by blowing upon the ball with the bellows above-mentioned, which had lain ſome hours not very far from the chimney-corner, (but without ſeeming to be ſenſibly warmed by the neighbourhood of the fire) a very few blaſts made the ſuſpended water haſtily ſubſide, (and thereby witneſs the expanſion, and ſo the warmth of the included air) and upon my ceaſing to blow, the ſame water would re-aſcend in the pipe, and that, though I ſtood near it to watch it, (which ſhews, that the former depreſſion was not cauſed by the approach of my warm body) and this I did more than once both alone and before witneſs, notwithſtanding that the air blown at the ſame time out of the ſame bellows upon our hand and face ſeemed cool enough. But fearing to inſiſt any longer in this matter in a Preface, I think it now unſeaſonable to add, that as ſome contingent experiments in ſubſequent trials may fail oftener, ſo others may, perchance, ſucceed oftener than is expected: as I have ſometimes obſerved in the figures, that appear in the ice made of ſome liquors, that abound with volatile, urinous, or with certain other ſalts. But to ſay a word in general of experiments, whoſe ſucceſs is not always uniform; as a magnetick needle, though it do not always preciſely reſpect the poles, but both declines ſometimes eaſtward, and ſometimes weſtward, and varies that declination uncertainly as to us, does nevertheleſs ſo far reſpect the North, as in ſpite of its variations to be an excellent guide to navigators; ſo there are contingent experiments, whoſe events, though they ſometimes vary, are ſeldom very exorbitant, but for the moſt part are regular enough to afford philoſophers very uſeful informations and directions.

If it be demanded, why in the 15th, 18th, and 19th ſections I have inſerted ſo many quotations out of ſeveral authors, and how that agrees with what I have ſaid, not far from the beginning of this Preface, of the uncultivatedneſs of the ſubject I have adventured on; I anſwer, that what I have done croſſes not what I have ſaid. For my complaint was, that there has been very little, eſpecially of any moment, delivered concerning cold, by claſſick authors; and that even other learned writers, who have had occaſion to ſay ſomething purpoſely of cold, have handled it exceedingly jejunely: but this hinders not, but that if a man will take the pains to ſeek out, and inquire of travellers, and has the curioſity to conſult voyages and navigations, he may, among a multitude of other things, that have nothing to do with cold, meet with ſome few, that concern that ſubject: and yet the authors, that deliver ſuch particulars, can no more properly be ſaid to have written profeſſedly of cold, than of botanicks, or zoology, or meteors, or civil philoſophy, becauſe in the ſame journal they mention a great froſt, or a great ſnow, as chancing to happen on ſuch a day, with as little particular deſign, as they mention a ſtorm, or a whale, or a bear, or the manners of an Indian people. This conſideration being premiſed, it will not be difficult to return an anſwer to the former part of the queſtion lately propoſed. For the unfrequency of my quotations in moſt of the ſections of the following hiſtory will, I preſume, ſufficiently perſuade the reader, that I would not needleſly employ ſo many of them in the three ſections, that are named in the quotation. But the writers of phyſicks being, for aught I know, ſilent as to the particulars I have tranſcribed out of other writers, and the obſervations being ſuch, as I could not my ſelf make in this temperate climate: I muſt either make uſe of other men's teſtimonies, or leave ſome of the remarkableſt phænomena of cold unmentioned. And they, that ſhall try, how much pains it will coſt them, to range among books, which many of them contain little but melancholy accounts of ſtorms and diſtreſſes, and ice, and bears, and foxes, to cull out here and there a paſſage fit to make a part of ſuch a collection, as they may here meet with, will poſſibly rather thank, than blame me, for having, to gratify my readers, given my ſelf ſo laborious and unpleaſant an entertainment. And I was the rather content to enlarge a little on the fore-mentioned occaſions, not only becauſe I was unwilling to be engaged more than once in ſo troubleſome an employment, but (and that chiefly) becauſe moſt of the particulars, I have collected out of navigators, are afforded me by the voyages of our own countrymen, who having written only in Engliſh an account of what their relations contain of moſt material concerning cold, will probably be welcome, as well as new, to the curious of other countries, who cannot underſtand their books; divers of which having been long out of print, are ſo hard to be procured, even here in *England*, that I doubt not, but theſe extracts of them will be acceptable, even to divers of the virtuoſi of our own nation; eſpecially ſince I have been careful to alledge moſt of the teſtimonies in the writer's own words, though they are not always the beſt, wherein the things he delivers might be expreſſed. And this courſe I the rather took, that I might do what I think very uſeful to be done by all writers of natural hiſtory, who would do well to diſtinguiſh more carefully, than hitherto many have done, betwixt the matters of fact, they deliver as upon their own knowledge, and thoſe, which they have but upon truſt from others. I know it would be more acceptable to moſt readers, if I were leſs punctual and ſcrupulous in my quotations; it being by many accounted a more genteel and maſterly way of writing, to cite others but ſeldom, and then to name only the authors, or mention what they ſay in the words of him, that cites, not theirs, that are cited. And there are ſome writers of ſuch known diligence and veracity, as to be ſafely truſted, and ſome caſes, wherein I do not diſlike, but comply with this cuſtom, (after having firſt conſulted my author to be maſter of his true and genuine ſenſe) but in matters hiſtorical, and whereon philoſophical and important truths are to be built, I ſhould think my ſelf beholden to a writer, for ſetting them down in ſuch a way, as that I may ſatisfy my ſelf, that the teſtimony is faithfully reported. In order to which, it will be ſometimes very uſeful to be enabled to repair to the original witneſs, and, if need be, ſurvey there the context of the alledged paſſage. For I muſt here advertiſe the reader, that in matters of any moment, it is not from every writer, that I dare truſt the quotations he makes of the paſſages of other authors, in his own words, not theirs: for upon comparing very many quotations, I have found, that oftentimes there is no ſuch thing, as is pretended to be really met with in the place referred to; and even when neither the book, nor chapter, nor page are miſquoted, I have too frequently found, that the alledgers of teſtimonies do either, through inadvertency, miſapprehend, or miſrecite the ſenſe of the author they quote, or out of deſign make him ſpeak that, which may comply with their own purpoſe, whether it were his own ſenſe or no: and by their indefinite citations made it too troubleſome and difficult a work, for the reader to find out, whether they have impoſed upon him or not. But it is only by the by; to return therefore to the paſſages we were ſpeaking of, in the 15th, 18th, and 19th ſections, I ſhall now add, that having in the beginning of the XIXth title of the enſuing hiſtory itſelf rendered an account of my not ſcrupling to aſſert ſome ſtrange relations concerning cold, it will not be requiſite to mention here, what the reader will meet with there. And I ſcarce doubt, but he will excuſe ſuch paſſages, if we conſider, that as I could not omit them, without leaving out ſome of the eminenteſt phænomena of cold, ſo being unable to examine them here in *England*, all I could do was, to report them faithfully, and mention only ſuch, as were either affirmed by eye-witneſſes, (as the moſt I have inſerted, are) or, at leaſt recommended by credible teſtimony, whereof we ſhall ſay more by and by: to which ſort of narratives I know not whether I may refer that, which (yet for its ſtrangeneſs may deſerve a tranſient mention) came a-while ſince to my ears, of an Engliſhman, who related to an eminent virtuoſo of our acquaintance, that a Dutch maſter of a ſhip, returning from the northern countries, very ſolemnly affirmed, being therein ſeconded by one of his countrymen, and offered to produce his journal for proof, that endeavouring to ſail northwards as far as he could, he came within leſs than a degree of the pole itſelf, and found the ſea open, and the cold very tolerable. But to return to what we were ſaying, before this odd relation diverted us, I did not only decline the mention of divers things, with which I fear many writers would have adorned a hiſtory of cold; but even of thoſe, that I my ſelf have inſerted, I would have left out divers, were it not, that many of the relations, that may appear ſo wonderful, ſeem not to me to be repugnant to the nature of things, but only ſuppoſe a far greater degree of cold, than we have in theſe parts; and yet the familiar effects of the cold we have here, would, perhaps, be looked on as incredible, by one, that was born and bred in the kingdom of *Congo*, where *Odoardus Lopez*, who lived long there, informs us, that ice, that is, water made ſolid, is ſo known a rarity, that it would there be valued as ſo much gold. And a learned phyſician, that lived in *Jamaica*, being aſked, how far he found the temperature of that country to be like that of *Congo*, anſwered me, that in that iſland he obſerved not all the winter long, either froſt or ſnow. And yet here it will not be unſeaſonable to ſay a word or two of the three principal authors, from whom moſt of our ſtrange relations we are conſidering, are tranſcribed.

THE firſt is *Gerat de Veer*, who writ the voyage of the Hollanders to *Nova Zembla*, a book ſo eminent in its kind, that it may ſeem a waſting of time to ſet down a character of it; and therefore I ſhall only advertiſe the reader of two things; the one, that the Dutch did, indeed, make three conſecutive voyages to *Nova Zembla*; but that the third being that, in which they wintered there, moſt of the particulars are to be underſtood of that. The other thing is, that having loſt the tranſlation, that was made of thoſe voyages out of Dutch into Engliſh, (publiſhed in a book by themſelves) without being able to procure another, I was obliged to have the citations tranſcribed, as I found them extant in that faithful collection of voyages compiled by

*Purchas*; who ſeems, by the ſtyle, to have (as to the book we are ſpeaking of) only plaid the part of an interpreter. And here it will be ſeaſonable to add, that whereas that excellent collection conſiſts of ſeveral diſtinct tomes or volumes, the many quotations to be met with, in the margin of our hiſtory under the name of *Purchas*, are to be underſtood (unleſs the contrary be intimated) to belong to the third part of his *Pilgrim*, where the Dutch and other voyages into the northern countries are to be found.

THE next book I intend to mention, is *Olaus Magnus*'s Hiſtory of the Northern Nations. And though this author is of very ſuſpected credit, and delivers ſome things upon hear-ſay, which they are kinder to him, than I, that are pleaſed to believe; for which reaſon I do but very ſparingly make uſe of his hiſtory; yet, conſidering, that he was archbiſhop of *Upſale* in *Sweden*, and appears to have more learning, than many, that never read his books, imagine; I thought I might, now and then, make uſe of his teſtimony in matters, wherein he either profeſſes himſelf to ſpeak upon his own knowledge, or delivers but ſuch things, as being conſiſtent with the laws of nature, appear improbable, only, becauſe of the intenſe cold, that they ſuppoſe: which I the rather ſay, becauſe he himſelf ſomewhere ſpeaking of the cold, that by the laws of nature reigns in the North, ſubjoins this paſſage, (*Lib.* 1. *Titulo de frig. aſperitate*, page 9.) *Sub quo quia natus, & verſatus ſum etiam circa elevationem graduum poli arctici* 86, *arbitror me poſſe hoc, & multis ſequentibus capitulis, nonnihil cæteris vaga opinione ſcribentibus clarius demonſtrare, quam vehemens & horrendum ſit illic frigus.*

AND, though perchance few readers will perceive it, I have been ſo ſevere in rejecting not only relations, but even authors not otherwiſe obſcure, that, how much ſoever I foreſaw my ſcrupulouſneſs might impoveriſh my hiſtory, yet there are ſome whole treatiſes about cold countries, whence I have ſhunned to borrow any one authority, becauſe I perceived the authors had not obſerved the things they recount themſelves, and were too eaſy in believing others.

THE third writer I meant to take notice of, is captain *James*, a perſon from whoſe journals I have borrowed more obſervations, than from thoſe of any other ſeamen, not only becauſe his book ſupplied me with them, and becauſe it is ſomewhat ſcarce, and not to be met with in *Purchas*'s tomes, (having been written ſome years after they were finiſhed) but becauſe this gentleman was much commended to me, both by ſome friends of mine, who were well acquainted with him, and by the eſteem, that competent judges appear to have made of him. For having been, not only imployed by the inquiſitive merchants of *Briſtol*, to diſcover a north-weſt paſſage into the South-ſea, but deſigned for ſo difficult a work by ſo judicious a prince, as the late king, and having, at his return, publiſhed his voyages by his Majeſty's command; as by theſe circumſtances, though not by theſe only, this gentleman's relations may well be repreſented to us, as likely to deſerve our conſideration and credit; ſo, by his breeding in the univerſity, and his acquaintance with the mathematicks, he was enabled to make far better uſe than an ordinary ſeaman would have done, if the opportunity he had to obſerve the phænomena of cold, by being forced to winter in a place, where he endured little (if at all) leſs extremity of cold, than that of *Nova Zembla*.

I PRESUME it will eaſily be taken notice of, that in the following hiſtory I have declined the aſſerting of any particular hypotheſis, concerning the adequate cauſe of cold. Not but that I may have long had conjectures about that matter, as well as other men, but I was willing to reſerve to myſelf an intire liberty of declaring what opinion I moſt inclined to, till the hiſtorical part being finiſhed, I may have the better opportunity to ſurvey and compare the phænomena; and the leiſure, (which I cannot promiſe myſelf in haſte) of calmly conſidering what theory may beſt agree with them:

eſpecially ſince I freely acknowledge, that I found the framing of an univerſal and unexceptionable hypotheſis of cold to be a work of greater difficulty, than every body would imagine; eſpecially to me, to whom ſome experiments, purpoſely made, have ſuggeſted a puzzling difficulty, which it is like that philoſophers have not yet thought of. And whatever applauſe is wont in this age to attend a forwardneſs to aſſert hypotheſes, yet, though fame were leſs to be ſought than truth, this will not much move me, whilſt I obſerve, that hypotheſes haſtily pitched upon do ſeldom keep their reputation long; and divers of them, that are highly applauded at the firſt, come, after a while, to be forſaken, even by thoſe, that deviſed them.

As for the title of the following book, I call the experiments new, becauſe indeed, if I miſtake not, nine parts of ten (not to ſay nineteen of twenty) are ſo. But though 150, or 200 experiments of that kind, beſides collections from travellers, and books, that do not profeſſedly treat of cold, may, I preſume, allow me to have begun the natural hiſtory of cold; yet, in the very title-page I think fit to intimate, that I look upon what I have done but as a beginning. For though ſome very noted virtuoſi have been pleaſed to ſeem ſurprized, to ſee what ſo barren and uncultivated a ſubject has been brought to afford this treatiſe; yet I look upon theſe as things, that do rather promiſe than preſent a harveſt, and but as ſome early ſheaves of that crop, which men's future induſtry will reap from a ſubject, that is indeed barren, but not unimproveable. For I ſee not, why it ſhould not hold in the hiſtory of cold, as well as in many other attempts, that the greateſt difficulties are wont to be met with at the beginning; and thoſe being once ſurmounted, the progreſs becomes far more eaſy. And as the magnetick needle, though it point directly but at the north and ſouth, does yet diſcover to the ſeaman the eaſt and weſt, and all the other points of the compaſs; ſo there are divers experiments, which though they do primarily and directly teach us but a notion or two, may yet aſſiſt us to diſcover, with eaſe, many other truths, to which they ſeemed not at firſt ſight to afford us a direction. So that what is here already done, ſuch as it is, partly by hinting various inquiries about cold, and partly by ſuggeſting ways not formerly practiſed of making farther experiments, may poſſibly make it more eaſy for others to add to theſe a number, far exceeding that, which they will here meet with, than it would have been without ſuch aſſiſtances, (which I had not) to contribute to the Hiſtory of Cold, even ſuch a ſtock as I have begun it with. And this I the rather incline to think, becauſe I find, that when once a man is in the right way of making inquiries into ſuch ſubjects, experiments and notions will reciprocally direct to one another, and ſuggeſt ſo many things to him, that if I were now to begin this work again, and had cold, and fitly-ſhaped glaſſes, and inſtruments, with other accommodations at command, there are divers parts, on which my inlargements would not, perchance, be much inferiour to what is already extant there, if they did not much exceed it. But beſides that I have other work enough, and that of a quite other nature upon my hands; the truth is, that I am plainly tired with writing on this ſubject, having never handled any part of natural philoſophy, that was ſo troubleſome, and full of hardſhips, as this has proved; eſpecially becauſe that not only the experiments being new, and many of them ſubject to miſcarriages, required to be almoſt conſtantly watched, but being unable to produce or intend cold, as we can do heat, nor command the experiments, that concern congelation, with as little difficulty, as we can do thoſe, that belong to divers other ſubjects; I was fain to wait for, and make uſe of a fit of froſty weather (which has very long been a rarity) as ſollicitouſly as pilots watch for, and improve a wind.

III. It remains now, that I give ſome account, why I ſuffer ſo unfiniſhed a piece, as I acknowledge this to be, to come forth at this time. And I confeſs, that if I had not preferred the gratifying the curious, before the advantages of my reputation, I ſhould have kept this book in my hands ſome winters longer, that it might come forth, both more rich, and leſs unpoliſhed. But how great a power my friends have with me in ſuch caſes, the reader may eaſily gueſs by the preamble he will find prefixed to the firſt title of the enſuing hiſtory. For by the date of that, he will ſee, how early my papers about cold were to have been communicated; nor was I any thing near ſo much befriended, as I expected, by thoſe interpoſing accidents, that have for above a year and half kept thoſe papers lying by me. For the then next, and now laſt winter proved ſo ſtrangely mild, as to be altogether unfavourable to ſuch a work as I had deſigned. Wherefore finding, that delays had done me no more ſervice, and preſſed by the ſollicitations of divers virtuoſi from ſeveral parts, I reſolved, that I would ſuſpend till another opportunity the drawing together of what I had obſerved or collected, touching the regions of the air, and ſome of the chief hypotheſes, that are controverted about cold, with what other looſe papers, touching that quality, I could not ſo readily diſpatch to the preſs; and would not withhold from the curious what aſſiſtance my collections could afford them, to make uſe of this winter to proſecute experiments of cold. And remembering how favourable an entertainment my former endeavours to gratify ingenious men had found among them, I took a courſe, wherein I was more likely to obtain thanks than praiſes, and choſe rather to adventure on the equity and favour of the reader, for the pardon of thoſe faults and imperfections, that are imputable to haſte, than to deny him the opportunity of this cold ſeaſon, wherein to examine the truth, and ſupply the deficiencies of what I had delivered. And this I the rather did, both becauſe I was deſirous to quit this ſubject for another, from which it had diverted me, and for which I have more value and kindneſs; and becauſe, that as a tender conſtitution of body kept me, whilſt I was writing the following hiſtory, from adventuring upon ſome trials, that might (probably) have enriched it; ſo the continuance of the ſame diſadvantages, together with other inopportune diſtempers ſuperadded to them, do not permit me to know, whether, and how far I ſhall be able to proſecute the work I have begun; and do oftentimes reduce me to be more concerned to ſhun the effects of cold, than obſerve the phænomena of it. And indeed, whether thoſe prove true prophets or no, that aſſure me I ſhall loſe no reputation by this hiſtory (as incompleat as it comes forth) I think, if ingenious men knew, how much trouble and exerciſe of my patience it has coſt me, they would, peradventure, vouchſafe me ſome of their thanks, if not for what I have done, yet for what I have ſuffered for their ſakes, (and would ſcarce have undergone upon any inferiour account whatſoever;) it being, though a leſs noble, yet no leſs troubleſome an imployment, to dig in mines of copper, than in thoſe of gold; and men being oftentimes obliged to ſuffer as much wet and cold, and dive as deep, to fetch up ſponges, as to fetch up pearls.

MVSEVM BRITANNICVM

# NEW THERMOMETRICAL EXPERIMENTS and THOUGHTS.

## DISCOURSE I.

### Propoſing the firſt Paradox, *viz. That not only our Senſes, but common Weather-glaſſes, may miſinform us about Cold.*

IT may to moſt men appear a work of needleſs curioſity, or ſuperfluous diligence, to examine ſollicitouſly, by what criterion or way of eſtimate the coldneſs of bodies, and the degrees of it are to be judged; ſince coldneſs being a tactile quality, it ſeems impertinent to ſeek for any other judges of it than the organs of that ſenſe, whoſe proper object it is. And accordingly, thoſe great philoſophers, *Democritus*, *Epicurus*, *Ariſtotle*, and (till of late) all others both ancient and modern, ſeem to have contented themſelves in the matter with the reports of their ſenſories.

But this notwithſtanding, ſince we can ſcarce imploy too much care and diligence in the examining of thoſe touchſtones, which we are to examine many other things by, perhaps it will be neither unſeaſonable nor uſeleſs to premiſe ſomething touching this ſubject.

For though it be true, that cold in its primary and moſt obvious notion be a thing relative to our organs of feeling, yet ſince it has alſo notable operations on divers other bodies beſides ours; and ſince ſome of them ſeem more ſenſible of its changes, and others are leſs uncertainly affected by them, it would be expedient to take in the effects of cold upon other bodies, in the eſtimates we make of the degrees of it.

And to make this appear the more reaſonable, I ſhall not ſcruple to propoſe the following paradox; namely, That our ſenſories, either alone, or aſſiſted by common weather-glaſſes, are not too confidently to be relied on in the judging of the degrees of cold.

To make this paradox plauſible (which is almoſt as much as I here pretend to) I ſhall repreſent in the firſt place, that the account, upon which we are wont to judge a body to be cold, ſeems to be, that we feel its particles leſs vehemently agitated than thoſe of our fingers, or other parts of the organ of touching. And conſequently, if the temper of that organ be changed, the object will appear more or leſs cold to us, though it ſelf continue of one and the ſame temper.

This may be exemplified by what has been obſerved by thoſe, that frequent baths, where the milder degrees of heat, that are uſed to prepare thoſe, that come in for the higher, ſeem very great to them, that coming out of the cold air, diſpoſe themſelves to go into the hot baths, but are thought cold and chilling to the ſame perſons, when they return thither out of much warmer places; which need not to be wondered at, ſince thoſe, that come out of the cold air, find that of the moderately warm room more agitated, than the cold ambient would ſuffer the external parts of their bodies to be; whereas the ſame warm air, having yet a leſs agitation than that, in which the hotter parts of the bath had put the ſenſitive parts of the bathers bodies, muſt ſeem cold and chilling to them.

But it is not only in ſuch caſes as this, wherein men can ſcarce avoid taking notice of a manifeſt change in themſelves, that theſe miſtaken reports of our ſenſes may have place. For oft-times we are impoſed upon by more ſecret changes in the diſpoſition of our ſenſories, when there needs ſomething of attention and of reaſoning, if not of philoſophy, to make us aware of them. For being apt to take it for granted, that our temper is the ſame, when there is no very manifeſt cauſe, why it ſhould be changed, we often impute that to objects, whereof the cauſe is in our ſelves; and if this change in our ſelves be wrought by unſuſpected agents, or by inſenſible degrees, we do not eaſily take notice of it.. Thus though in ſummer divers cellars, that are not deep, are perhaps no colder than the external air was (when it was judged but temperate) in winter or the ſpring; yet it will ſeem very cold to us, that bring into it bodies heated by the ſummer ſun, and accuſtomed to a warmer air; nay, cold does ſo much depend upon the degree of agitation in the parts of the object, in reference to the ſentient, that even when we may think the ſenſory unaltered, it may judge an object to have a degree of coldneſs which indeed it hath not; as I remember, that to ſatisfy ſome friends, that it is not every wind, which feels cold to us, that is really more cold than the ſtill air, I have ſometimes ſhewn, that in not nice weather-glaſſes, air blown out of a pair of bellows does not appear to have acquired any coldneſs by being turned into wind, though if it were blown againſt the hands or face, it would produce a new and manifeſt ſenſe of cold: of which the reaſon ſeems to be, that though the organ in general ſeems not to be altered, yet the wind, by reaſon of its motion, is able not only to drive away the parts of the air contiguous to the hand or face, and the warm ſteams of the body, which tempered its coldneſs; but to pierce deeper than the calm air is wont to do into the pores of the ſkin, where, by compariſon to the more inward and hotter parts of the ſenſory, it muſt needs appear leſs agitated and conſequently colder.

BESIDES that ſometimes we may meet with certain ſteams in the air, that have in reference to the blood and ſpirits of human bodies (though not perhaps to divers other liquors) a certain hidden power of chilling, as opium, even in outward applications, (for in ſuch ways I have known a great ſurgeon much uſe it and highly extol it) ſtrikes a coldneſs into the body by the ſubtile effluviums, that inſinuate themſelves at the pores of the ſkin; and perhaps too that coldneſs is aſcribed to external bodies, which is produced in us by ſome frigorifick vapour, or other diſtemper: which being too ſlight to be taken notice of as a diſeaſe, may yet be of kin to thoſe agents, that produce what phyſicians call horrours and rigours at the beginning of fevers, and ſome other diſtempers; or produce that ſtrange and univerſal coldneſs of the external parts, which is frequently enough obſerved among other ſymptoms in hyſterical women. Moreover, bodies may often appear colder to us than to a weather-glaſs, becauſe our ſenſories are more affected by the denſity and penetrancy of the parts. This may ſeem ſomewhat ſtrange, but being ſuitable enough to ſome of my conjectures about cold, I have often made trials with very nice weather-glaſſes, that have aſſured me, that (at leaſt oft-times) when water ſeems to be cold enough to our touch, it appears not to be colder to the weather-glaſs than the ambient air.

THESE trials I have ſometimes made with ſealed weather-glaſſes, but the moſt with another ſort of weather-glaſſes (whoſe ſtructure and uſe are by and by to be mentioned) which though they ſeldom prove durable, nor of any great uſe in any other than ſuch nice and ſhort experiments, yet they diſcover ſlighter changes of the temper of the air, than would be notable (not to ſay ſenſible) in ordinary thermometers. But of multitudes of trials, that I ſometimes made with theſe glaſſes, I can at preſent find among my looſe papers but a very few; and though I remember, that in one or two (made about the ſame time with ſome of thoſe that follow) I obſerved things, that make me now wiſh I had had opportunity to make thoſe further trials of them, which ſome of their phænomena ſeem to direct the making of; yet I ſhall annex theſe that follow, as I find them entered, becauſe

they

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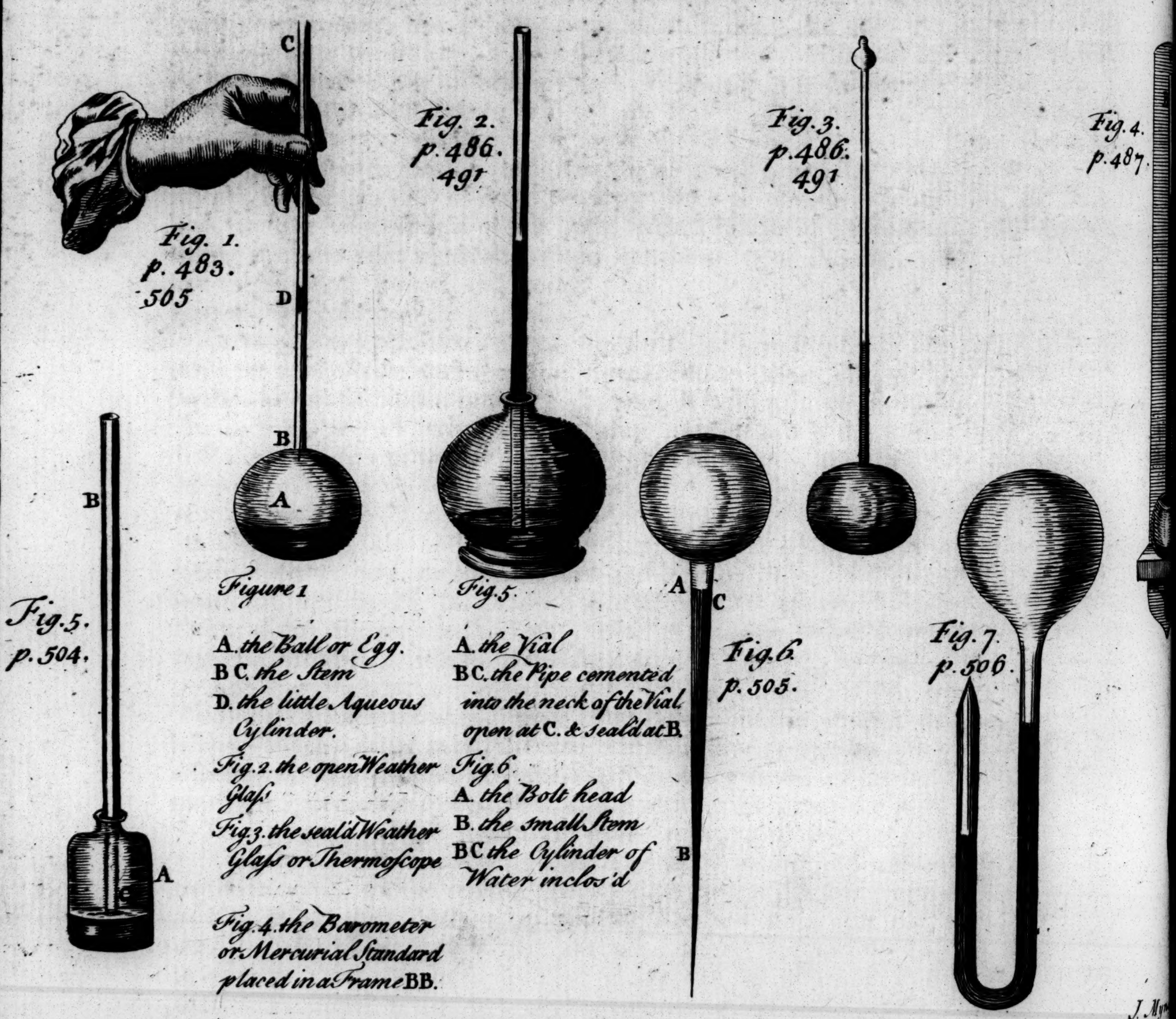
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*Figure 1*

A. *the Ball or Egg.*
B C. *the Stem*
D. *the little Aqueous Cylinder.*
*Fig. 2. the open Weather Glaſs*
*Fig. 3. the seal'd Weather Glaſs or Thermoſcope*

*Fig. 4. the Barometer or Mercurial Standard placed in a Frame* BB.

*Fig. 5.*

A. *the Vial*
BC. *the Pipe cemented into the neck of the Vial. open at* C. *& seald at* B.
*Fig. 6.*
A. *the Bolt head*
B. *the small Stem*
BC *the Cylinder of Water incloſ'd*

J. Myn

they are not perhaps deſtitute of hints improveable by further proſecution. *June* 26. between two and four in the afternoon (the weather moderate for the ſeaſon) I took a thin white glaſs-egg blown at a lamp about the bigneſs of a walnut, with a ſtem coming out of it about the bigneſs of a large pigeon's quill four or five inches long, and open at the top; this ſlender pipe being dipped in water, admitted into its cavity a little cylinder of water, of half an inch long or ſomewhat more, which (the glaſs being erected) ſubſided by its own weight, or the temper of the air in the egg (in reference to the outward air) till it fell to the lower part of the pipe, where it comes out of the egg, and thereabout it would reſt. Now if taking this glaſs by the top betwixt my thumb and forefinger, I depreſt the egg under the ſurface of a baſon of fair water (cold enough to the touch) the little aqueous cylinder, that parted betwixt the air in the egg, and the external, would, inſtead of being made to ſubſide by the egg's immerſion into cold water, preſently riſe up from the lower part of the pipe, till it reached about the middle of it, though the glaſs were, in this and the following trials, held erected; and as ſoon as it was taken out of the water into the air, the water would again ſubſide, whether I held the glaſs, or let it reſt upon the boards, or a linnen carpet, that covered the tables, on which the trials were made. And this I did ſeveral times as well with as without witneſſes. I tried alſo that if, inſtead of water, I made uſe of quickſilver, though not big enough to cover the egg much above half way, and in the reſt proceeded as above; the cold quickſilver would preſently make the aqueous cylinder haſtily aſcend near three inches, ſometimes almoſt, and ſometimes quite to the top of the ſlender pipe, whence the water would again quickly ſubſide, when the glaſs was taken out into the free air, or ſet to reſt upright as before.

BESIDES, having ſet the veſſel of quick-ſilver and the baſon of water very near one another, I did at leaſt upon three or four ſeveral trials find, as I expected, that when by immerſing the egg in water, the pendulous cylinder was raiſed ſo high, that it did no longer ſenſibly aſcend, by nimbly taking the egg out of the water and depreſſing it in the quickſilver, it would riſe far higher: and I alſo tried, that nimbly removing the egg out of the quickſilver into the water, the pendulous cylinder would ſubſide, after plunging the egg under water, though not ſo faſt, nor near ſo low, as it would do, in caſe the glaſs were removed from the quickſilver into the air. Upon another trial made much about this time, though not the ſelf-ſame day; the pendulous water in the ſame glaſs, (the day being for the moſt part windy and rainy) did ſubſide upon the immerſion of the glaſs into water, not only a while before noon, but an hour or two after dinner, and at diſtant hours afterwards, though the deſcent of the pendulous water was neither quick, nor ſo conſiderable, as it had been formerly in the mornings.

*June* 27. IN the morning a ſmall cylinder of water pendulous in the above mentioned glaſs, upon the immerſion of the egg in a baſon of water, would immediately and very conſiderably ſubſide; whereas the ſame glaſs, being immerſed in the veſſel of quickſilver formerly mentioned, would preſently aſcend. Both parts of this experiment we ſeveral times tried, and the reaſon was ſuſpected to be, that the quickſilver had ſtaid all night in my chamber, which was ſomewhat warm, whereas the water was brought up that morning, and to the touch ſeemed colder than the quickſilver; and a while after dinner, the ſame water having been ſtill kept in the room, we divers times found, that as well that, as the quickſilver, did immediately, upon immerſion, impell up the pendulous water in the ſlender pipe. Another time in the froſty weather (and about the beginning of *January*) we did with ſuch a glaſs (as has been already ſeveral times mentioned) take ſome drops of water out of a veſſel, wherein that liquor had for a good while been kept; that it might be reduced as near as we could to the temperature of the ambient air; then ſuffering the ſuſpended water to continue a convenient while in the long and ſlender ſtem of the weather-glaſs, that the internal air might be reduced to the temper of the external, we took up the glaſs by the open end; and immerſing the obtuſe part of it into a ſhallow veſſel, containing ſome of the above mentioned water, we found the ſuſpended drop ſuddenly impelled upwards about half an inch or more, and the ball of the thermometer being taken out of the water into the air, the pendulous drop did again (though far more ſlowly than it aſcended) ſubſide. This was repeated three or four times with ſome intervals between (and that in a room where there was no chimney) and ſtill with the like ſucceſs, ſave that in the two laſt trials we took the weather-glaſs out of the ſhallow water, and plunging it into a deep veſſel of the ſame water (that ſtood very near the other) we found (for further confirmation of the experiment) that the pendulous water was, upon theſe new immerſions, impelled up, near (if not full) as high again, as when we had immerſed it only in the ſhallow veſſel: and taking it out of this deep glaſs, we found the cold of the external air to reduce it to its former humble ſtation. Thus far the notes, I have yet been able to recover: and though, as I ſaid, I dare not build very much upon them, yet by ſmall ſealed weather-glaſſes I find enough to invite me to ſuſpect, that of the degrees of heat and cold in the air we may receive differing informations, when we imploy only our organs of touching, and when we make uſe of fit inſtruments.

I SHALL add on this occaſion, that not only water itſelf, but moiſt vapours abounding in the air, may make us think it colder than the weather-glaſs diſcovers it to be. For though it be generally taken for granted, that the thermometer does only more exactly meaſure or determine the effects, which cold hath both upon it and upon our ſenſories; yet I have long ſuſpected there is ſomewhat elſe in the caſe, and I have obſerved, that ſometimes the weather ſeemed more or leſs cold to me, than that which preceded, when the contrary appeared in the weather-glaſs; and that, when upon conſideration of the whole matter, that difference did not appear to depend upon thoſe circumſtances of exerciſe or reſt, or the temperature of the air I came out of, or any of thoſe other things, to which a conſiderate man, that goes upon no better than the common opinions about weather-glaſſes, would be apt to impute to that phænomenon. And I was the leſs diſpoſed to think my ſelf miſtaken, becauſe having purpoſely enquired of others in the ſame houſe, who were not told, what information the weather-glaſs gave, they agreed with me in the ſenſe I had of the temperature of the weather. And having ſince, as occaſion ſerved, communicated my obſervations and ſuſpicions to divers ingenious men, I have been by their recenter obſervations confirmed, that what I have taken notice of, was not the effect of any Ἰδιοσυγκρασία. From which and other particulars, that we may have elſewhere opportunity to mention, we may plauſibly enough infer, that it were not amiſs, not only to take notice, when we have opportunity, of the ſenſe, that is expreſſed of the degrees of cold by birds and other animals, whoſe diet is more ſimple and regular than ours, and whoſe perceptions are commonly more delicate and leſs diverted; but eſpecially, to examine the coldneſs of the air and other bodies as well by experiments and inſtruments, as by the touch. And on this occaſion I muſt not pretermit that memorable account, that is given us by *Martinius*, in that noble piece of geography, which he calls *Atlas Chinenſis*, where ſpeaking of the air of that populous country, he has this ſingular paſſage: *Ad cæli* (ſays he) *ſolique temperiem quod attinet, majus in hac provinciâ frigus eſt, quàm illius poſcat poli altitudo; vix enim illa excedit gradum ſecundum ſupra quadrageſimum;* & *tamen per integros quatuor ſæpe menſes flumina omnia adeò durè concreſcunt gelu, ut currus equoſque ac graviſſima etiam onera glacies ferat, innoxiè ac ſecuriſſimè tranſeant: ex iis* *ingentia etiam glaciei fruſta exſcinduntur, quæ in futuram æſtatem ad delicias ſervant. His menſibus omnes naves ita in ipſâ glacie defixæ ſunt, ut progredi nequeant ubicunque illas frigus occupat (quod certo certius circa medium Novembris ingruere ſolet) per quatuor illos menſes immotæ ibi perſtare coguntur, neque enim reſolvitur glacies ante Martii initium; hæc plerumque glaciei concretio uno fit die, cum non niſi pluribus fiat liquefactio.* To which he adds, what makes moſt to our preſent purpoſe, *omnino illud mirum, tantum non videri aut ſentiri illud frigus, ut Europæos ad hypocauſta ſubeunda videatur poſſe cogere, aut in Europâ ad glaciem producendam ſufficere, unde ad ſubterraneas illic exhalationes pro harum rerum cauſis indagandis omnino recurrendum eſt*, &c.

BUT all that I have been implying of the neceſſity and uſefulneſs of the weather-glaſs, is no ways inconſiſtent with the truth of the latter part of our formerly propoſed paradox; namely, that we are not raſhly to rely upon the informations even of common weather-glaſſes themſelves. For though they be an excellent invention, and their informations, in many caſes, preferable to thoſe of our ſenſes, becauſe thoſe dead engines are not, in ſuch caſes, obnoxious to the ſame cauſes of uncertainty with our living bodies; yet I fear they have too much aſcribed to them, when they are looked upon as ſuch exact inſtruments to meaſure heat and cold by, that we neither can have, nor need deſire any better. For, not yet to mention ſome inconveniencies in the contrivance of them, which makes them unapplicable to ſome purpoſes, and leſs proper in others, than thermoſcopes might be made, even in divers caſes, wherein they are preſumed to be unexceptionable, their reports are not to me, I confeſs, quite exempt from ſuſpicion. For, in ordinary weather-glaſſes, ſome part of the liquor being contiguous to the external air, it is ſubject to be impelled more or leſs upwards, not only according as heat or cold affects the included air, but according as the incumbent air happens to be heavier or lighter. And though this be a thing not taken notice of by thoſe, that have treated of weather-glaſſes, yet after what we have elſewhere manifeſted concerning the weight and ſpring of the air, and what we have probably conjectured concerning the varying height of the mercurial cylinder in the Torricellian experiment; I ſee not why it ſhould not much call in queſtion the informations we receive from common weather-glaſſes in thoſe caſes, where the height or weight of the atmoſpherical pillar, that preſſes upon the water in the weather-glaſs, is conſiderably longer or ſhorter, lighter or heavier than is uſual.

See the 18th of our New Phyſico-Mechanical Experiments.

FOR beſides the reaſon of the thing, we have experience on our ſide. I might mention, on this occaſion, an experiment I thought on, and alſo attempted, laſt winter, to ſhow, even upon a ballance, the varying gravity of the atmoſphere in one and the ſame place, by hanging a ſmall metalline weight at one end of a pair of ſcales ſo ſtrangely exact, that they would turn with far leſs than the five hundredth part of a grain; and counterpoiſing it at the other end with a hermetically ſealed glaſs bubble, which being blown as large and as thin as could poſſibly be procured of ſo ſmall a weight, might, by its great diſproportion in bulk to the metalline body, loſe more of its weight than that would upon the ambient air's growing more heavy. But the particular account of this attempt belonging to another place, the trial ought not be more than hinted here; eſpecially ſince it may ſuffice for our preſent purpoſe to alledge, that having found (as we have already in other papers noted) that in a weather-glaſs, where the water is not fenced from the external air, the weight of the atmoſphere may make it alter conſiderably between the top and the bottom even of a church or ſteeple, though it appeared by more certain thermoſcopes, that it was not the differing temperature of the air, as to cold and heat, but the differing gravity of the atmoſphere, which being ſhorter and lighter at the top, preſſed leſs forcibly upon the ſubjacent water and the included air, as is more fully made out in the treatiſe above

In the Defence againſt Linus, chap. 4.

above related to. And having, by the intervention of a learned acquaintance, deſired to have ſome experiments made of the effect of the air upon weather-glaſſes in deep pits or mines, where the atmoſpherical cylinder is longer and heavier, I received information, that an ingenious phyſician, (Dr. *H. P.*) who had the opportunity of trying what I deſired, had found, that in the bottom of one of thoſe very deep pits, the water, in a common weather-glaſs, roſe near three inches higher than at the top, in a ſhank or pipe of about thirty inches long. And this notwithſtanding the warmth, that is uſual in ſuch deep places, which ſeems not any thing near ſo plauſibly referrible to any other cauſe, as to the increaſed gravity of the atmoſpherical pillar incumbent on the water, that pillar being heavier at the bottom than at the mouth of the pit, by the weight of an aërial pillar equal in length to the pit's perpendicular height or depth.

BUT theſe are not the only caſes, wherein the differing gravities of the atmoſphere may, as well as heat and cold, have an intereſt in the riſing and falling of the liquor in common weather-glaſſes. For though you ſhould not remove them out of one place; and though conſequently it may ſeem, that the atmoſpherical pillar, that preſſes upon the water, muſt be ſtill of the ſame length, yet (not to urge, that that may alter unknown to us) if retaining its length it retain not its gravity, we may be eaſily impoſed upon, and take that aſcenſion or ſubſidence of the liquor for the effect of a higher or remiſs degree of cold, which may either totally or at leaſt in part (and in what part, we are left to gueſs) be the effect of the increaſed or leſſened weight of the atmoſpherical pillar, happening either by the copious diſperſion of vapours and other heavy ſteams through the air, or upon other occaſions not neceſſary to be here diſcourſed of, or by the precipitation of ſuch vapours by rain, or into dew, or elſe by the removal of the occaſions of the augmented gravity or preſſure of the air. For we have often obſerved great variations to happen in the height of the mercurial cylinder, in the Torricellian experiment, upon great rains and fogs, and other ſudden and conſiderable mutations of the incumbent air. But ſince I myſelf thought fit, notwithſtanding the plauſible ratiocination, that led me to this conjecture, to examine it by experience; I can ſcarce doubt, but that others may have the like curioſity that I had. And therefore, becauſe it may ſeem a paradox, it will not be amiſs, of many to annex three or four trials I made to examine the propoſed doctrine, eſpecially ours having been the firſt obſervations of this kind, that, for aught we know, have been made by any. And indeed others could ſcarce have well made much, though they lighted on the ſame thoughts, for want of ſuch ſealed weather-glaſſes to make them with. To omit then thoſe, that I made with a ſealed weather-glaſs, and an ordinary one (in which the water remains ſuſpended beneath the included air) I ſhall briefly relate, that in a room unfurniſhed with a chimney, I kept two weather-glaſſes, which, for more exactneſs ſake, I cauſed to be made of a length far greater than ordinary; ſo that the diviſions of the one were half inches, and thoſe of the other not much leſs, and yet were numerous. The one of theſe, which was furniſhed with good ſpirits of wine, was ſealed, the other not; but this laſt I cauſed to be ſo made of the ſhape repreſented by the ſcheme, that the air being ſhut up in the lower part of the inſtrument (not as in common weather-glaſſes at the top) the liquor might as well in this, as in the ſealed weather-glaſs, riſe with heat and fall with cold. In theſe thermoſcopes (where the aſcenſion and relapſe of the liquors were, by reaſon of the length of the pipes, far more conſpicuous than in vulgar weather-glaſſes) I obſerved, with pleaſure, that the hermetical thermoſcope (if I may for diſtinction-ſake ſo call it, by reaſon of its being hermetically ſealed) did regularly enough deſcend in cold weather, and aſcend in warm: but the other, which was not ſealed, but had a little hole left open at the top of the pipe, though, when the atmoſphere continued of the ſame weight, it would, like the other, riſe with heat and fall with cold, yet when the atmoſphere's gravity was altered, they would not uniformly move together, but when (as we gathered from other obſervations) the atmoſphere grew heavier, the liquor in the pipe did not aſcend, as high as it would have done, if the atmoſphere had continued in its former degree of gravitation. And, on the contrary, when the incumbent air came to be lighter, the liquor would riſe in the open weather-glaſs in a proportion greater than the ſingle increaſe of heat would have exacted; ſo that by comparing the two weather-glaſſes together, I did uſually foretel, whether the mercury in the Torricellian tube (which I keep purpoſely by me in a frame) were riſen or fallen, and conſequently whether the external air were heavier or lighter than before: As, on the other ſide, by looking on the height of the mercurial cylinder, I could eaſily tell before-hand, whether the liquor in the open weather-glaſs were higher or lower than that in the hermetical; the riſing or falling of the mercurial cylinder one quarter of an inch (the temperature of the air continuing as to heat and cold) uſually ſignifying a great diſparity betwixt the aſcenſion or the falling of the liquors in the two inſtruments.

AMONG the ſeveral notes, I find among my looſe papers, and in a diary I kept for a while of theſe obſervations, I ſhall content my ſelf to tranſcribe the following two, becauſe, though divers others were made by my Amanuenſis, whoſe care is not to be diſtruſted, yet by reaſon of my abſence I could not take notice of them myſelf. The firſt of theſe *Memorandums* runs thus.

LAST night I took notice, that there was but one or two diviſions difference betwixt the two thermometers, but upon ſuch a change of weather, that happened this day, as made me imagine, that the atmoſphere would be lighter than before, conſulting the barometer (if to avoid circumlocutions, I may ſo call the whole inſtrument wherein a mercurial cylinder of 29 or 30 inches is kept ſuſpended after the manner of the Torricellian experiment) I found the quickſilver lower than it had been a great while, and thereupon concluding, there would be a notable diſparity, between the ſealed and open weather-glaſs, I haſted to them, and found that the latter being much alleviated from the weight of the incumbent air, was no leſs than 17 diviſions higher than the others; and comparing the height the two inſtruments were this day at, with an obſervation I my ſelf made about a week ago, when the quickſilver was much higher than now it is; I found, that although this afternoon the ſealed glaſs being at 41, the other was 58, yet then, when the ſealed weather-glaſs was five diviſions higher, namely, at 46, the unſealed weather-glaſs was but at 27. So that betwixt that time and this, the liquor in the ſealed weather-glaſs, has deſcended five diviſions, but that in the open weather-glaſs has aſcended 31.

THUS far the firſt of the above mentioned notes; the ſecond is as follows.

THE mercurial cylinder being higher, than it has been a good while, and yet the weather warm and ſun-ſhiny, when the liquor in the ſealed glaſs ſtood very near the 50th diviſion, that in the unſealed was fallen down as low as the 32d.

So that it is very poſſible, that the unheeded change in the weight of the external air may have a greater power to compreſs the included air in an unſealed weather-glaſs, than a not inconſiderable degree of warmth may have to dilate it; and conſequently in an ordinary weather-glaſs, where the air is included at the top, it may often fall out, that contrary to what men ſuppoſe muſt needs happen, the pendulous water may riſe in warmer weather and fall in colder.

AND even ſince the writing of the immediately foregoing page, within a few days that intervened, I have myſelf made obſervations, that do yet more clearly manifeſt this truth, as may appear by the following notes. The firſt of which ſpeaks thus.

*Memorandum*, THAT yeſterday night the quickſilver being at 29 inches, the liquors in the ſealed and unſealed weather-glaſſes were near about the ſame diviſion, the former being at 40, and the other being but half a diviſion ſhort of that number. But this night the quickſilver being riſen about $\frac{1}{4}$ of an inch; the liquor in the ſealed is aſcended to 45, and the other deſcended beneath 35 about half a diviſion, ſo that there are now 10 diviſions between them.

THIS the firſt note, to which the following night enabled me to add this other.

THE quickſilver being riſen almoſt $\frac{3}{4}$ of an inch above the ſtation it reſted at, the night before laſt night, the hermetical weather-glaſs being as it was then above the 40th diviſion; the liquor in the other, which was open, in two days and nights is fallen to the 17th, and conſequently is ſubſided about 23 diviſions, whilſt the other is about the ſame height, at which it was at the beginning of that time.

TWO or three days after, being returned to the place, wherein I had made this laſt obſervation, and from which ſome urgent occaſions had for that time exacted my abſence; I found the diſparity betwixt the two thermometers, that is expreſſed in the following memorial.

THIS day the quickſilver being riſen to 30 inches, when the liquor in the ſealed weather-glaſs was at about 41 diviſions, that in the other was depreſſed a pretty deal below the 9th diviſion; ſo that the difference between the two thermometers was increaſed ſince the laſt obſervation from 23 near to 33 diviſions, all which the liquor in the open weather-glaſs had ſunk down, whilſt that in the ſealed continued almoſt at a ſtand. And the day after this memorial, I had occaſion to regiſter another, which being the laſt, I ſhall here think requiſite to take notice of in this diſcourſe, I ſhall ſubjoin it with that, which immediately preceeded in order of time.

THIS day the quickſilver continuing at the ſame height, at which I obſerved it yeſterday, but the weather being grown much colder, the liquor appears in both the glaſſes to have uniformly enough ſubſided; that in the ſealed weather-glaſs being about the 33d, and the other being ſunk quite below the loweſt mark of all, which was more than I apprehended it would have done, when there was no froſt: eſpecially ſince by my diary it appears, that one of the laſt times I obſerved the hermetical weather-glaſs to ſtand at near about the ſame height, namely, the 34th; the liquor in the other glaſs was no lower than 41: nor probably would there be now ſo great a difference, if the atmoſphere had not been this day very heavy; whereas, when this freſhly-recited obſervation was made, I find by the diary, the quickſilver to have aſcended but to 29 inches, and a pretty deal leſs than a half.

SINCE that time, being forced by ſeveral avocations to be often abſent from the place where my thermoſcopes were kept, I was not careful to proſecute ſuch obſervations, thoſe already ſet down (not to mention thoſe, that are not here tranſcribed) being judged abundantly ſufficient to evince the paradox propoſed to be proved by them: only to manifeſt, that after I deſiſted from regiſtering my obſervations, the phænomena may probably have been as remarkable as before; I ſhall add, that one of the laſt times I chanced to take notice of the difference to be gathered by comparing the two weather-glaſſes, I found (the weather happening to be warmer than ordinary) the difference between them to exceed any, that I remembered my ſelf to have then obſerved, amounting to 44, if not to 45 diviſions.

And even ſince the writing of the laſt line, we have had opportunity to obſerve a phænomenon, which if it had occurred to us in the place, where we might have compared the baroſcope with the exact weather-glaſſes hitherto mentioned, (and whereby we had been invited to rely upon it) would perhaps appear more conſiderable, than any of the obſervations yet recorded. For not very many hours ago, finding in the morning the quickſilver to be riſen in a good baroſcope of mine (though another from that, all this while referred to, and elſewhere kept) above $\frac{1}{4}$ of an inch higher than the place it reſted at the night foregoing, and a ſomewhat nice weather-glaſs (where the included air is kept in the lower part of the inſtrument, which is ſhaped like that already deſcribed in this diſcourſe) being conſulted to ſhow, what effect ſo great and ſudden a change of the atmoſphere's gravity would have upon it; I ſaw the tincted liquor in the ſhank depreſſed a full inch or more beneath the ſurface of the ambient liquor in the phial, which ſtrange depreſſion of the liquor in a pipe above 20 inches long, and where the alterations of the air as to heat and cold are not wont to produce any thing near ſo great an effect, I could not but take much notice of. Since the ſeaſon of the year makes it no way likely, that the night, though cold, could have had ſo powerful an operation on it, eſpecially ſince an amanuenſis, that watched it much longer than I, affirms, that he ſaw the liquor driven down quite to the very bottom of the pipe, and a bubble of the outward air to make its paſſage through the water, and to join with the air contained in the cavity of the phial.

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# DISCOURSE II.

## *Containing ſome new Obſervations about the Deficiencies of* WEATHER-GLASSES, *together with ſome Conſiderations touching the New or Hermetical Thermometers.*

AND ſince I had occaſion to ſpeak of the deficiencies of weather-glaſſes, and the miſtakes, whereto men are liable in the judgment they make of cold and heat upon their informations, it will not perhaps appear impertinent to add three or four conſiderations more, to excite men to the greater warineſs and induſtry, both in the making and uſing weather-glaſſes, and in their judging by them.

I. And firſt, I conſider, that we are very much to ſeek for a ſtandard, or certain meaſure of cold, as we have ſettled ſtandards for weight, and magnitude, and time: ſo that when a man mentions an acre, or an ounce, or an hour, they, that hear him, know what he means, and can eaſily exhibit the ſame meaſure: but as for the degrees of cold (as we have elſewhere noted concerning thoſe of heat) we have as yet no certain and practicable way of determining them; for, though, if I uſe a weather-glaſs long, it is eaſy for me to find, when the weather is colder, or when warmer, than it was at the time, when the weather-glaſs was firſt finiſhed; yet that is a way of eſtimating, whereby I may in ſome degrees ſatisfy myſelf, but cannot ſo well inſtruct others, ſince I have no certain way to know determinately, ſo as to be able to communicate my knowledge to a remote correſpondent, what degree of coldneſs or heat there was in the air, when I firſt finiſhed my thermoſcope: for beſides that we want diſtinct names for the ſeveral gradual differences of coldneſs, we have already declared, that our ſenſe of feeling cannot ſafely be relied upon to meaſure them. And as for the weather-glaſs, that is a thing, which, in this caſe, is ſuppoſed to be no fit ſtandard to tell us what was preciſely the temper of the air, when itſelf was firſt finiſhed, ſince that does but inform us of the receſſions from it, or elſe that the air continues in the temper it was in at the making of the inſtrument, but does not determine for us that temper, and enable us to expreſs it; as indeed it is ſo mutable a thing, even in the ſame place, and oft-times in the ſame day, if not the ſame hour, that it ſeems little elſe than a moral impoſſibility, to ſettle ſuch an univerſal and procurable ſtandard of cold, as we have of ſeveral other things. And indeed there is ſcarce any quality, for whoſe differences we have fewer diſtinct names, having ſcarce any for the many degrees of coldneſs, that may be conceived to be intermediate, betwixt lukewarmneſs and the freezing degree of cold, and even theſe are undefined enough; for that, which to ſome men's ſenſes will feel lukewarm, by others will be judged hot, and by others, perhaps, cold; nor is even the glaciating degree of coldneſs well determined, ſince not only differing liquors, as oil, wine, and water, will manifeſtly freeze much more eaſily one than another, but even liquors of the ſame denomination; and of waters themſelves, ſome are more eaſily turned into ice than others: and I ſee no great cauſe to doubt, but that there may be ſufficiently differing degrees of cold, whereof the mildeſt may ſuffice for the congelation of ſome waters. I muſt not forget to add, that the ſame perſon, that has made many obſervations with a weather-glaſs, is ſo confined by that numerical inſtrument, that, if by the ſpilling of the liquor, or the cracking of the glaſs, or the caſual intruſion of ſome bubbles of air, or by any of divers other accidents, that may happen, the inſtrument ſhould be ſpoiled, he would, though he ſhould employ again the ſame inſtrument, be reduced to ſeek out a new ſtandard, wherewith to meaſure the varying temperature of the air. And though it be not difficult to include in the cavity of a weather-glaſs ſome other fluid body inſtead of air, yet it will be very difficult, if not impoſſible, to include a body, fit to reſent and ſhow the alterations of the ambient air, without being alſo liable to receive impreſſions from it at the time of its being firſt ſhut up.

YET I will not here omit, that I have ſometimes conſidered, whether the eſſential oil of aniſeeds (which is that, that is diſtilled by the intervention of water in a limbeck) might not, during a good part of the year, be of ſome uſe to us, in making and judging of weather-glaſſes. For this liquor, as we elſewhere alſo note, having the peculiarity of loſing its fluidity during almoſt all the winter, and a good part of the ſpring, and autumn too, when the weather, or the time of the day, is colder; this liquor, I ſay, being ſuch, in caſe you very gently thaw it, and then putting into it the ball of a weather-glaſs, furniſhed with ſpirit of wine, that will burn all away, you ſuffer the oil to re-congeal leiſurely of itſelf, you may, by obſerving the ſtation of the ſpirit of wine in the thermoſcope, when the oil begins manifeſtly to curdle about it, be in ſome meaſure aſſiſted to make another weather-glaſs like it*. For if you put ſuch rectified ſpirit of wine into a glaſs, the cavity of whoſe ſpherical, and that of its cylindrical part, are as near, as may be, equal to the correſpondent cavities in the former glaſs, you may, by ſome heedful trials made with thawed and recongealed oil of aniſeeds, bring the ſecond weather-glaſs to be ſomewhat like the firſt; and if you know the quantity of your ſpirit of wine, you may eaſily enough make an eſtimate, by the place it reaches to in the neck of the inſtrument, whoſe capacity you alſo know, whether it expands or contracts itſelf to the 40th, the 30th, or the 20th part, *&c.* of the bulk it was of, when the weather-glaſs was made. By the help of the ſame oil you may make ſome kind of eſtimate, though a more uncertain one, of the difference of two weather-glaſſes of unequal bigneſs: and though I know not how much may be alledged to ſhew the uncertainty of this way of making a ſtandard for weather-glaſſes; yet as what I have formerly repreſented may manifeſt me to be far enough from looking on it as an exact ſtandard of cold; ſo perhaps the way propoſed may not be altogether uſeleſs in the making and comparing weather-glaſſes, ſince, in ſuch caſes, where we are not to expect to hit the mark itſelf, it is of ſome advantage to be able to ſhoot leſs wide of it, than otherwiſe we ſhould.

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* An ingenious man has propoſed another way of ſettling a ſtandard for weather-glaſſes, namely, by obſerving the coldneſs, which is requiſite to make diſtilled water begin to freeze: but though the accurateneſs of this way may be as well as the other juſtly queſtioned, and cannot often be put in practice, even in winter itſelf, nor without trouble; yet it may alſo be advantagiouſly made uſe of, when the cold happens to be great enough to freeze water.

II. BUT not to inſiſt any further on a difficulty, which is ſo hardly evitable as that, which occurs about ſettling a perfect ſtandard of cold, there are unaccurateneſſes in the meaſuring of cold by weather-glaſſes, which may be avoided, but are not; for men are not wont to take care, that the ſtems be even and cylindrical enough, but are wont to make uſe of ſuch, as are much wider at the upper part near the bubble, than otherwhere; nor do they obſerve, as they might, a proportion betwixt the diameter of the bore of the cylinder, and that of the cavity of the ſpherical bubble, and divers other circumſtances are commonly neglected, which, if well ordered, would make much towards the certainty and inſtructiveneſs of the informations, afforded us by weather-glaſſes. To which may be added, that even in thoſe, where ſome part of the liquor is expoſed to the external air, there may be made contrivances much more convenient, in order, at leaſt, to ſome particular purpoſes, than that of the vulgar weather-glaſs; ſome of which we have imployed, and others have been either ſkilfully deviſed, or alſo happily attempted by ſome eminently ingenious members of the Royal Society. And though that, which we have already deſcribed in another treatiſe, be very ſimple, yet it is much more commodious for ſeveral of the following experiments of cold, than that, which is commonly in uſe. For in this, where the included air is as it were pendulous at the top of the glaſs, it is very troubleſome and difficult ſo to apply cold bodies, and eſpecially liquid ones to it, as therewith to meaſure their temper; whereas the thermometers, I ſpeak of, being made by the inſertion of a cylindrical pipe of glaſs (open at both ends) into a phial or bottle, and by exactly ſtopping with ſealing-wax, or very cloſe cement, the mouth of the phial, that the included air may have no communication with the external, but by the newly-mentioned pipe: in this kind of inſtrument, I ſay, by chuſing a phial as large as you pleaſe, and fitting it with a cylinder, ſlender enough, the proportion between the part of the phial poſſeſt by the included air, and the cavity of the cylinder, in which the liquor is to play up and down, may be eaſily made ſo great, as to make the liquor in this inſtrument, with the ſame degree of heat and cold, riſe or fall four or five, or more times, as much as the pendulous liquor is wont to do in an ordinary weather-glaſs, where the cavity that lodges the air, is wont to be much too ſmall, conſidering the bigneſs of the pipe, whereinto the air muſt, when it is rarified, expand itſelf. But it is not the greater ſenſibility (if I may ſo ſpeak) of this very kind of weather-glaſſes, nor their not needing frames, that makes me take notice of

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them in this place, (where I purpoſely paſs by contrivances that I know to be more curious) but this other quality, which makes them fit for divers of the following experiments, wherein we ſhall have occaſion to mention them; namely, that with little or no trouble and inconvenience we may imploy liquors or other bodies to refrigerate the included air, by immerſing the phial, if need be (by a weight) into the liquor to be examined, and letting it ſtand there as long as we pleaſe. And ſo we may alſo meaſure the coldneſs of earth, ſnow, powdered ice, and other conſiſtent bodies, which may be heaped about the phial, or in which it may be buried.

III. I CONSIDER too, that though men are wont confidently enough to conclude, that in caſe (for inſtance) the coldneſs of the weather make the liquor in a thermoſcope yeſterday an inch higher than it was the day before, and this day an inch higher than it was yeſterday, the air muſt be this day as cold again as it was yeſterday, or at leaſt that the increaſe of cold muſt be double to what it was yeſterday, and ſo in other proportions; yet the validity of this collection may very juſtly be queſtioned; for, though we ſhould grant, that cold is that, which of itſelf, or by its own power, contracts the air, yet how does it appear, that a double degree of cold muſt produce a double degree of condenſation in the air, and not either more or leſs? Since beſides that it is taken for granted, but not proved, that the differing qualities of included air in ſeveral inſtruments, and the differing bigneſſes of the pipes, and the differing degrees of expanſion, wherein the included air may happen to be, when the aſcenſion of the water begins to be reckoned, may render this hypotheſis very ſuſpicious; beſides all this, (I ſay) I am not inclined to grant, (what philoſophers have hitherto ſuppoſed) that the condenſation of the air, and the aſcenſion of the water, is only, or ſo much as principally, collected by the proper virtue of the cold, but by the preſſure of the ambient air, as we ſhall ere long more fully declare. And if this be made out, then the computation, we are conſidering, will be found to be very fallacious; for we have elſewhere ſhewn, *that the ſtrengths required to compreſs air are in reciprocal proportion, or thereabouts, to the ſpaces comprehending the ſame portion of air.* So that if a cylinder (for inſtance) of four inches of air, be juſt able to reſiſt a ſtrength or preſſure equivalent to ten pound weight, when it comes to be compreſſed into two inches; in this caſe, I ſay, an equal force ſuperadded to the former, (which makes that a double force, or equivalent to twenty pound weight) will drive up that already-compreſt air into half the ſpace; that is, into one inch or thereabouts. Whence it follows, that in eſtimating the condenſation of the air in a weather-glaſs, we muſt not only conſider, how much ſpace it is made to deſert, but alſo, what proportion that deſerted ſpace bears to the whole ſpace it formerly poſſeſt, and to what degree of denſity it was reduced, before the application of the then force; and we muſt remember, that the reſiſtance of the included air is not to be looked upon, as that of a weight, which may remain always the ſame, but that of a ſpring forcibly bent, and which is increaſed more and more, as it is crouded into leſs and leſs room. But theſe nicer ſpeculations it would here be ſomewhat improper to purſue.

Defence againſt Linus, chap. 5.

IV. WHEREFORE I ſhall proceed to what may ſeem a paradox, that even the particular nature of the liquors, employed in weather-glaſſes, is not altogether to be neglected, till we have a better and more determinate theory of the cauſes of cold, than I fear we have: for, though uſually it matters not much, what liquor you employ, yet it is not impoſſible, that in ſome caſes men may ſlip into miſtakes about them; for it will not follow, that if of two liquors, the one be much the more obnoxious to the higher degree of cold, that of glaciation, the other muſt be leſs eaſily ſuſceptible of the lower degrees of cold; ſince thoſe, that make ſealed weather-glaſſes, ſome with water, and ſome with ſpirit of wine, have confeſſed to me, that they find theſe (laſt named) much more apt to receive notable impreſſions from faint degrees of cold, than thoſe, that are furniſhed but with water, which yet is eaſily turned into ice by the cold of our climate, which will by no means produce the like effect upon pure ſpirit of wine.

Besides, we cannot always ſafely conclude (as philoſophers and chymiſts generally do) that the more ſubtile and ſpirituous liquors muſt be the leaſt capable of being congealed (that is, made to loſe its fluidity, as oil and ſome other ſubſtances are wont to be reduced to do, by the action of cold) for the chymical oil of aniſeeds diſtilled by a limbeck is ſo hot and ſtrong a liquor, that a few drops of it conveniently diſſolved will make a whole cup of beer taſte as ſtrong, and, perhaps, heat the body as much as ſo much wine; and yet this hot and ſubtile liquor I have found upon trial, purpoſely made, to be more eaſily congealable (in the ſenſe freſhly explained) by cold than even common water, and to continue ſo ſeveral days, after a thaw had reſolved the common ice into fluid water again. And I know ſome diſtilled liquors, whoſe component particles are ſo piercing and ſo vehemently agitated, that the tongue cannot ſuffer them, and that they are not perhaps inferiour to moſt chymical oils, nor to aqua fortis it ſelf; and yet theſe may be congealed by far leſs degrees of cold, than ſuch, as would yet prove ineffectual to freeze either the generality of chymical oils, or the generality of ſaline ſpirits.

And indeed, till we attain to ſome more determinate theory of cold, and come to know more touching its cauſes, than we yet do, I ſee not, why it ſhould be abſurd to ſuſpect, that though there be ſome kind of bodies, which ſeem fitted to produce cold indiſcriminately in the bodies they invade or touch; yet if the refrigeration of a body be but the leſſening of the wonted or former agitation of its parts (from what cauſe ſoever that remiſſneſs proceeds) it ſeems not impoſſible, but that beſides thoſe bodies or corpuſcles, that may be looked upon as the catholick efficients of cold, there may be particular agents, which in reference to this or that particular body may be called frigorifick; though they would not ſo much refrigerate another body, which perhaps would be more eaſily affected, than the former, by other efficients of cold. For we may obſerve, that quickſilver may be congealed by the ſteams of lead, which have not been taken notice of to have any ſuch effect, upon any other fluid body; and yet quickſilver is not to be deprived of its fluidity by ſuch a degree of cold, as would freeze not only water but wine. And by what we have formerly related upon the credit of that great traveller, the Jeſuit *Martinius*, it ſeems, that water it ſelf may in ſome regions be ſo diſpoſed by the conſtitution of the ſoil, that it is ſuſceptible of ſtrange impreſſions of cold in proportion to the effect, which that degree of cold produces there in human bodies. Beſides, opium alſo, of which three or four grains have too oft deſtroyed the heat of the whole maſs of blood in a man's body, though that be a very hot, ſubtile, and ſpirituous liquor, does not ſenſibly refrigerate water, as far as I could obſerve with a good ſealed weather-glaſs, which I put ſometimes in a glaſs of ordinary water, and ſometimes into a glaſs of water of the ſame temper, and (as we gueſſed) of the ſame quantity, wherein opium, enough to kill very many men, was put in thin ſlices, and ſuffered to diſſolve; which ſeems to argue, that as differing liquors have each their peculiar texture, ſo there may be certain bodies, whoſe minute particles by their peculiar ſize, ſhape, and motion, may be qualified to hinder, or at leaſt leſſen, the agitation of the particles of the appropriated liquor, into whoſe pores they inſinuate themſelves; and thereby, according to the lately mentioned ſuppoſition, they may refrigerate that particular liquor, without having the like effect on other liquors, whoſe textures are differing. And I might countenance this by adding, that as fiery and agitated a ſpirit as that of wine, when well dephlegmed, is juſtly thought to be; yet I know more liquors than one, that being mingled with it, will in a trice deprive it of its fluidity; and the like change I have ſometimes made in ſome other liquors alſo. But I muſt not inſiſt on ſuch matters, having mentioned them but only to awaken men's curioſity and circumſpection, and not to build much upon them; which will be eaſily credited, if it be remembered, that a little above I my ſelf ſufficiently intimated, that this conjecture ſuppoſes ſomething about the theory of cold, which is not yet ſufficiently cleared. Only, becauſe the former experiments ſhew, that the various agitation of the minute parts of a liquor, whereon its fluidity depends, may be hindered or ſuppreſſed by the intervention of adventitious corpuſcles, but do not clearly ſhew, that the liquor by being deprived of that kind of agitation does actually acquire a coldneſs; I might ſubjoin thus much, that by the addition of a certain ſubſtance (which for juſt reaſons I muſt forbear to deſcribe) that would ſcarce ſenſibly refrigerate common water; I can make a certain (and for aught I know, one only) liquor, that is wont to the touch to be much of the temper of water, to receive a conſiderable degree of coldneſs. This, I ſay, (as ſtrange as it may ſeem) I might here ſubjoin to countenance the conjectures I have been delivering, and afford ſome new corollaries; but for the reaſon newly intimated I forbear, and the rather, becauſe I think it high time to return thither, whence the conſiderations, I have offered about weather-glaſſes, have made me digreſs.

I WAS going then to take notice, upon the occaſion offered by what I related of the influence of the atmoſphere's gravity upon common weather-glaſſes, of the difference between them and thoſe that are hermetically ſealed. And indeed theſe are in ſome things ſo much more convenient than the others, that (if I be not miſtaken) it has already proved ſomewhat ſerviceable to the inquiſitive, that I have directed the making of the firſt of them, that have been blown in *England*. At the beginning indeed I had difficulty to bring men to believe, there would be a rarefaction and condenſation of a liquor hermetically ſealed up, becauſe of the ſchool-doctrine touching the impoſſibility of a vacuum, and eſpecially, becauſe I had never ſeen any experiment of this kind, nor met with any that had: but after ſome trials, which my conjectures led me to make ſucceſsfully enough, that in hermetically ſealed glaſſes, both air and water might be alternately rarified and condenſed; I found my work much facilitated by the ſight of a ſmall ſealed weather-glaſs, newly brought by an ingenious traveller from *Florence*, where it ſeems ſome of the eminent virtuoſi, that ennobled that fair city, had got the ſtart of us in reducing ſealed glaſſes into a convenient ſhape for thermoſcopes. But ſince that, the invention has in *England* by a dexterous hand, that uſes to make them for me, been improved, and the glaſſes we now uſe are more conveniently ſhaped, and more exact than the pattern, I cauſed the firſt to be made by. But the filling of theſe long ones, that we now uſe, is a work of more niceneſs and difficulty, than they, that have not tried, will be apt to imagine, and therefore may elſewhere deſerve either from our pen, or his, that is moſt verſed in making them, a more particular account of the way of performing it; the advantages of theſe weather-glaſſes being at no hand inconſiderable. For, the weight or preſſure of the atmoſphere (which, as we have noted, may work very much upon others) their being ſealed defends them from: and by this advantage they may be uſed in the higheſt and in the deepeſt places, with as much certainty as any where elſe. Next, whereas in other thermometers the liquor is very ſubject to be ſpilt, in caſe they be removed from place to place, and, which is worſe, though they be not removed, is ſubject to be preyed upon and waſted by the air, whereby informations of ſuch weather-glaſſes are rendered in tract of time ſomewhat uncertain; in ſealed weather-glaſſes, there is no danger, that liquor ſhould either ſpill or evaporate. And upon the ſame account, theſe have this advantage, that you may ſafely let them down into the ſea, and immerſe them in any liquor, you pleaſe, without excepting the moſt corroſive to examine their coldneſs: not to mention, that inſtead of the coarſer liquors uſed in common weather-glaſſes, which are ſome of them not unapt to freeze, and others unapt enough to comply with the ſlighter alterations of the air, and inſtead of the colourleſs liquor, whether water or no (I know not) uſed in the Florentine weather-glaſs I ſaw, we employ highly rectified ſpirit of wine, whoſe being brought to a lovely red with cochineal, opened by the moſt ſubtile volatile ſpirit of urine, by which means the included liquor is not only very conſpicuous and ſecured from freezing, but ſo ſuſceptible of even the ſlighter impreſſions of external bodies (which would work but faintly on water) that 'tis pleaſant to ſee, how many inches a mild degree of heat will make the tincture aſcend in the very ſlender cylindrical ſtem of one of theſe uſeful inſtruments; of which we have ſpoken the more particularly in this place, becauſe we ſhall have frequent occaſions to mention them in the following papers; and no body as yet, that we know, has written any account of them.

BUT though theſe weather-glaſſes be much more to be relied on, than thoſe, that are commonly in uſe, yet we would have a philoſopher look upon both theſe and our ſenſories, but as inſtruments to be imployed by his reaſon, when he makes his eſtimates of the coldneſs of bodies: and though perhaps it will ſignify nothing in the event, yet I ſee not, why it ſhould miſbecome a naturaliſt's diligence and circumſpection, to try, whether even ſuch weather-glaſſes ought to be ſo far allowed of, as to hinder men from looking after any other kind of ways of eſtimating cold.

FOR, though the ſealing of theſe weather-glaſſes protect the included liquor from the preſſure of the air, and keep it from evaporating, yet it will not follow from hence, that they muſt be exempt from all the other imperfections, which we formerly mentioned to be imputable to weather-glaſſes.

I KNOW not, whether you will allow me to add on this occaſion, that tincted ſpirit of wine (and the like may, for aught we know, be ſaid of any ſuch liquor) being a particular mixture, in caſe it be allowed poſſible, that the ſubtile ſteams of ſuch bodies (as we formerly noted to be frigorifick in reſpect to ſome liquors) may inſinuate themſelves through the pores of glaſs; as it is granted, that the effluviums of the loadſtone do readily permeate it: in this caſe, I ſay, though I willingly allow it not to be likely, yet it is not abſolutely impoſſible, that ſome ſteams, that wander through the air, may be more or leſs cold, or may more promote or hinder an agitation among the minute parts in reference to it, than in reference to other liquors: as we formerly noted, that a grain or two of opium will exceedingly allay the warmth and motion of the whole maſs of blood in a man's body, though ten times that quantity will not ſenſibly refrigerate the tenth part of ſo much water. And that this may appear the leſs extravagant, I ſhall here add ſome mention of an odd phænomenon, that, as it were, by ſome fate has occurred to me, ſince I began the diſcourſe I am now upon: for whilſt I was yeſterday writing it, I had occaſion to examine by ſuch a ſealed weather-glaſs (as I have been ſpeaking of) the temper of a certain ſtrange kind of mixture, that towards the cloſe of this treatiſe, I ſhall have occaſion to take ſpecial notice of: and though to the touch it appeared but lukewarm, yet having put into it the ball, and part of the ſtem of the ſealed weather-glaſs, I found the included liquor ſlowly enough impelled up ſo high, that at length, to my wonder, it roſe eight or nine inches in a ſtem, which was not much above a foot long. But that which I relate, as the ſurprizing circumſtance, is, that when I had taken out the thermoſcope, and removed it again into a deep glaſs full of cold water, whence I had juſt before taken it out, to put it into the anomalous mixture, I had a mind to examine; the tincture in the weather-glaſs did not (as it was wont, and as any one would have expected) begin to ſubſide again towards its former ſtation, but continued within about half an inch or leſs of the very top of the inſtrument, though neither my own buſy eyes, nor thoſe of a perſon very well verſed in making and uſing thermoſcopes, could perceive, that the expanded tincture was any where diſcontinued by any air or bubbles, which at firſt we ſuſpected might poſſibly (though it were very unlikely) have been generated by the tepor of the mixture. But that, which continued our wonder, if not increaſed it, was, that during four or five hours, that the inſtrument continued in the cold water, and during ſome hours alſo, that it was expoſed to the air, the tincture did not ſubſide above half an inch; and, which is yet more ſtrange, having left the glaſs all night in the window of a room, where there was no chimney, I found in the morning, that its deſcent was ſcarce ſenſibly greater, for it continued about eight inches higher than the mark it ſtood at, when I firſt put it into the luke-warm mixture; and how long it will retain this ſtrange expanſion, is more than I can tell. But by this, and what I may have occaſion hereafter to relate, concerning this mixture, it may appear ſomewhat the more reaſonable to ſuſpect, than even ſealed weather-glaſſes furniſhed with high rectified ſpirit of wine, may in ſome (though very rare) conjunctures of circumſtances, and from ſome peculiar agents, either by their inſinuating themſelves through the pores of the glaſs, or on ſome other account, receive impreſſions, that, as far as can eaſily be diſcerned, are not purely the genuine and wonted operations of heat and cold.

Theatr. Chymic. vol. 6.

THE chymiſt *Orthelius* tells us, that the liquor diſtilled from the ore of magneſia or biſmuth (which ſeems to be the ſame mineral that we, in Engliſh, call tin-glaſs) will ſwell in the glaſs it is kept in, not only manifeſtly, but very conſiderably at the full moon, and ſhrink at the new moon; and if all my endeavours to procure that ore had not proved fruitleſs, I ſhould be able, by my own experience, to diſprove or confirm ſo admirable a phænomenon: but being as yet unfurniſhed to make the trial myſelf, leſt it might appear a vanity, ſo much as to mention (without rejecting it) a thing ſo very unlikely; I ſhall add, that ſince I find the thing, for the main, which was delivered by the chymiſt, employed as an argument by a famous mathematician (the Jeſuit *Caſatus**) whoſe expreſſions are ſuch, as if he himſelf had obſerved, that even in ſtopt glaſſes, the fore-mentioned mineral ſpirit increaſed very ſenſibly in bulk about the time of the full moon; which wonder being admitted, may not only countenance what we were ſaying, but hint ſome other very ſtrange things in nature. This brings into my mind, (what I have elſewhere mentioned) that a tincture of amber I had made with high rectified ſpirit of wine, did, for many months, in a well-ſtopt glaſs, diſcover itſelf to be affected with certain changes, which were thought to proceed from ſome ſecret mutations of the air, that did ſenſibly ſo work, as I had not obſerved it to do upon other liquors, wherein the ſpirit of wine abounded. And, perhaps, upon long and diligent obſervation, one might find a diſparity betwixt weather-glaſſes kept in the ſame place, but furniſhed with differing liquors; a diſparity, I ſay, that could not be ſo well aſcribed to any thing, as to the peculiar nature of the reſpective liquors, which, though of divers kinds, may (to add towards the facilitation of trials) be made of a very conſpicuous colour, by the ſelf-ſame metal, copper, which not only gives the known colour in aqua fortis, but affords us a fair ſolution in aqua regis, and it makes a liquor of a deep and lovely blue in ſpirit of urine, or of ſal armoniac, and the like: nay, I have found, that in good chymical oil of turpentine (for expreſſed oils are too eaſily congealed) the bare filings of it will yield a ſufficient tincture. But becauſe it is yet but a bare ſuſpicion, that ſealed weather-glaſſes, made of differing liquors, but in other points alike, may be otherwiſe uniformly affected by the temperature of the external air; I ſhall now add an obſervation already made, to ſhew, that even the ſealed weather-glaſſes, furniſhed with ſpirit of wine, are not ſo perfectly ſecluded from all commerce with external bodies, and liableneſs to their operations, but that they may be wrought upon otherwiſe than we think. For I have more than once obſerved, that even in ſealed thermoſcopes (made purpoſely at home for me, and with great care, by the experteſt maker of them) after a good while, and when no ſuch matter was expected, there have emerged bubbles, which, whether they proceeded from ſome undiſcernible particles of air, harboured in the pores of the water, which, in proceſs of time, by their union, came to make conſpicuous bubbles, or from ſome diſpoſed particles of the ſpirit of wine itſelf, by ſucceſſive alterations, brought to a ſtate of elaſticity, I now examine not; but only affirm, that ſometimes I have had, of theſe bubbles, great enough to poſſeſs the ſpace of many inches, in the ſhank of a long ſealed weather-glaſs, and I have been troubled with them in more weather-glaſſes than one or two: which I therefore take notice of, not only becauſe it ſerves to prove what I was ſaying, but becauſe it is very fit an advertiſement ſhould be given of it to prevent miſtakes. For when theſe bubbles are ſmall, and are generated, or happen to ſtay at or about the place where the ſpherical and cylindrical parts of the glaſs meet, they may eaſily (as I have obſerved) lurk unheeded, and reaching from ſide to ſide, ſo divide the ſpirit of wine in the ball from that in the ſtem, that the latter ſhall not be able to riſe and fall according to the changes of the weather; the bubble, notwithſtanding its aërial nature, being more indiſpoſed to be moved up and down in the ſlender ſtem of a ſmall weather-glaſs, than the ſpirit of wine itſelf, as we have elſewhere ſhewn, that when air is not forced, a bubble of it will not, in ſeveral caſes, ſo readily paſs through a very narrow paſſage, as would that groſſer fluid, water.

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* *Vitrum optimè clauſum ne quid exſpirare poſſet, in loco ubi quieſceret, ſtatui, nec ſine animi voluptate licebat in pleniluniis manifeſta incluſi liquoris incrementa obſervare, in novilunis vero decrementa,* &c. They are the words of *Paulus Caſatus*, in his *Terra Machinis mota*, Page 143. But ſince the writing of theſe preliminary diſcourſes, the author of them having conſulted, by the means of ſome ingenious friends, the learned *Caſatus*, finds, that he never made or ſaw the experiment himſelf, but relates it upon the authority of a certain Dutchman, whoſe name he adds not, and who therefore may probably be the ſame *Orthelius*, that is mentioned by the author of theſe preliminary diſcourſes; who thinks it requiſite to give the reader this advertiſement, becauſe *Caſatus* himſelf did not, as he ſhould have done, intimate, that he delivered this but upon another's credit.

BUT all theſe difficulties (not to call them extravagancies) which I have been mentioning about ſealed weather-glaſſes, I repreſent not to ſhew, that it is (at leaſt as yet) worth while to ſuſpect us ſo far, as to employ all the diligence and inventions, that were requiſite to prevent or ſilence the ſuſpicions of a ſceptick, or that might be thought upon, in caſe the matter did require or deſerve ſuch extraordinary nicety, but only to give men a riſe to conſider, whether it would be amiſs to take in (when occaſion preſents itſelf) as many collateral experiments and obſervations, as conveniently we can, to be made uſe of, as well as our ſenſories and weather-glaſſes, in the dijudications of cold. And, perhaps, an attentive enquiry, purpoſely made, would diſcover to us ſeveral other bodies, natural or factitious, which we might make ſome uſe of in eſtimating the degrees of cold. For though (to give an inſtance) water be thought to be the liquor, that is moſt ſuſceptible of ſuch an intenſity of cold, as will deſtroy or ſuſpend its fluidity; yet, not here to repeat what we formerly delivered of the eaſy congealableneſs of oil of aniſeeds, we have (as we elſewhere note to another purpoſe) diſtilled a ſubſtance from benzoin, which becomes of a fluid, a conſiſtent body, and may be reduced to the ſtate of fluidity again by very much leſſer alterations of the ambient air, as to heat and cold, than would have produced ice or thawed it. I could alſo here take notice of what I have ſometimes obſerved in amber-greaſe, diſſolved in high rectified ſpirit of wine, or in other ſulphureous or reſinous concretions diſſolved in the ſame liquor: for now and then, though it ſeemed a meer liquor in warm weather, it would in cold weather let go part of what it ſwallowed up, and afterwards re-diſſolve it upon the return of warm weather; ſome of theſe concretions, as I have ſeen in excellent amber-greaſe, ſhooting into fine figured maſſes, others being more rudely congealed. And I might alſo add, what I have obſerved in chymical liquors, (not unſkilfully prepared out of urine, hartſhorn, *&c.*) which would ſometimes ſeem to be totally clear ſpirits, and at other times would ſuffer a greater or leſſer proportion of ſalt to cryſtallize at the bottom, according to the mutations of the weather, in point of cold and heat. Such kind of inſtances (I ſay) I could mention, but I ſhall rather chuſe to proſecute my examples in that obviouſeſt of liquors, water; and add, that even that may afford us other teſtimonies of the increaſed or leſſened cold of the air, than that which it gives us in common weather-glaſſes. For in ſome parts of *France* the watermen obſerve, that the rivers will bear boats heavier loaded in winter, than in ſummer; and I have upon inquiry been credibly informed, that ſeamen have obſerved their ſhips to draw leſs water upon the coaſts of frozen regions (where yet the ſea is wont to be leſs brackiſh) than they do on our Britiſh ſeas: which argues, that water is thicker and heavier in winter than in ſummer. Nay, I ſhall add, that not only in differing ſeaſons of the year, but even at ſeveral times of the ſame day, I have often obſerved the coldneſs of the air to be (regularly enough) ſo much greater at one time of the day than at another, that a glaſs bubble hermetically ſealed and poiſed ſo as to be exactly of the ſame weight with its equal bulk of water, as that liquor was conſtituted at one time of the day, would about noon, when the warmth, that the ſummer's ſun produced in the air, had ſomewhat rarified the water, and thereby made it, bulk for bulk, ſomewhat lighter than before, the bubble would ſink to the bottom of the water, which (for the better marking the experiment) I kept in a glaſs-tube; but when at night the coolneſs of the air had recondenſed the water, and thereby made it heavier, it began, by little and little, to buoy up the bubble, which uſually by morning regained the top of the water; and at other times of the day it not unfrequently happened, that the bubble continued ſwimming up and down betwixt the top and the bottom, without reaching either of them, ſometimes ſtaying ſo long in the ſame part of the tube, that it much ſurprized divers of the virtuoſi themſelves, who thought the poiſing of weight ſo nicely, not only a very great difficulty (as indeed it is) but an inſuperable one. But of this experiment I elſewhere ſay more; and becauſe about other weather-glaſſes, I have ſaid ſo much already, I think it may not be improper to ſum up my thoughts concerning the criteria of cold, by repreſenting the following particulars:

L'Hydrographie du P. Fournier, Liv. 18. cap. 12.

1. THAT by reaſon of the various and unheeded pre-diſpoſitions of our bodies, the ſingle and immediate informations of our ſenſes are not always to be truſted.

2. THAT though common weather-glaſſes are uſeful inſtruments, and the informations they give us are in moſt caſes preferable to thoſe of our ſenſe of touching, in regard of their not being ſo ſubject to unheeded mutations; yet even theſe inſtruments being ſubject to be wrought upon by the different weights of the atmoſphere, as well as by heat and cold, may (upon that and perhaps ſome other accounts) eaſily miſinform us in ſeveral caſes, unleſs in ſuch caſes we obſerved by other inſtruments the preſent weight of the atmoſphere.

3. THAT the ſealed weather-glaſſes, we have been mentioning, are ſo far preferable to the common ones, as (eſpecially they not being obnoxious to the various preſſure of the external air) that there ſeems no need in moſt caſes to decline their reports, or poſtpone them to thoſe of any other inſtruments: but yet in ſome nice caſes it may be prudent (where it may conveniently be done) to make uſe alſo of other ways of examining the coldneſs of bodies, that the concurrence or variance to be met with in ſuch ways of examination, may either confirm the teſtimony of the weather-glaſs, or excite or aſſiſt us to a further and ſeverer inquiry.

4. THAT I would not have men too eaſily deterred from deviſing and trying various experiments (if otherwiſe not unlikely or irrational) about the eſtimating of cold, by their appearing diſagreeable to the vulgar notions about that quality. For I doubt, our theory of cold is not only very imperfect, but in great part ill grounded. And I ſhould never have ventured at trying to make ſealed weather-glaſſes, if I could have been withheld either by the grand Peripatetick opinion, that (to ſhun a void) water muſt remain ſuſpended in glaſſes, where, if it fall, the air cannot ſucceed it; or the general opinion even of philoſophers as well new as old, that air muſt be far eaſier, than any viſible liquor, condenſed by cold.

## DISCOURSE III.

### Containing the ſecond Paradox, *viz. Touching the Cauſe of the Condenſation of Air, and Aſcent of Water by Cold in common Weather-glaſſes.*

THOUGH I thought here to end the preliminary diſcourſe, as doubting it may be thought prolix enough already, yet for confirmation of what I was lately noting, about the incompleteneſs of the theory of cold, (and becauſe the evincement thereof may give riſe to many trials, that may inrich the hiſtory of cold) I will here ſubjoin a diſcourſe formerly written on another occaſion. For though upon that account I am fain to leave out the beginning of it, as not ſuited to the preſent occaſion, yet the main body of the diſcourſe may be (I think not improperly) annexed to what has been already ſaid about weather-glaſſes; ſince it examines the cauſes of the principal phænomenon of them, and will perhaps help to diſcover the incompleteneſs of men's notions about cold, by ſhewing, that the true cauſe, even of the moſt obvious phænomenon of common weather-glaſſes (though almoſt every man thinks he underſtands it) has not yet been ſufficiently inquired into.

THE diſcourſe then, that firſt part of it (as foreign to our preſent purpoſe) being omitted, is as follows.

——— To proſecute our diſquiſition ſatisfactorily, it will concern us to conſider, upon what account the water riſes in cold weather, and falls in hot, in common weather-glaſſes, whoſe conſtruction being ſo well known, that we need not to ſpend time to ſet it down, we may forthwith proceed to take notice, that concerning the reaſon, why in theſe weather-glaſſes the water, or other liquor in the ſhank or pipe, aſcends with cold, and deſcends with heat; there are three opinions, that will deſerve our conſideration.

THE firſt is the common opinion of the ſchools and Peripateticks, and indeed of the generality of learned men of differing ſects, who teach, that the cold of the external air, contracting the air included in the weather-glaſs, and thereby reducing it into a narrower room than formerly it poſſeſſed, the water muſt neceſſarily aſcend to fill the place deſerted by the retired air, leſt that ſpace ſhould become a vacuum, which nature abhors.

BUT againſt this explication, we have ſeveral things to object.

FOR firſt, I am not ſatisfied, that any of the ſchoolmen or Peripateticks (at leaſt of thoſe I have met with) have ſolidly evinced, that nature cannot be brought to admit of a vacuum. Nor do I much expect to ſee that aſſertion well proved, by theſe, or by any other, that forbear to make uſe of the argument of the Carteſians drawn from the nature of a body, whoſe very eſſence they place in its having extenſion: which I ſay, becauſe about this argument I neither have yet publiſhed, nor do now intend to deliver my thoughts.

NEXT, it ſeems a way of explicating, that little becomes a naturaliſt, to attribute to the ſenſeleſs and inanimate body of water an aim at the good of the univerſe, ſtrong enough to make it act, as if it were a free agent, contrary to the tendency of its own private nature, to prevent a vacuum, that, as is preſumed, would be hurtful to the univerſe.

BUT theſe arguments we have elſewhere urged, and therefore need not inſiſt longer on them here.

THIRDLY, If you take a bolt-head, with a large ball and long ſtem, and do, with that and quickſilver, make the Torricellian experiment, there will be an inſtrument prepared like a common weather-glaſs, ſave that the ſtem is longer, and that the liquor is mercury inſtead of water; and yet in this caſe we ſee not, that the mercury, which remains pendulous in the pipe at the height of about thirty inches, offers to aſcend into the cavity of the bolt-head, to fill up the ſpace, whence the air was expelled by the mercury, and which the quickſilver alſo by its ſubſiding deſerted. And the outward application of cold bodies to the forſaken part of the head will not, perhaps, occaſion the riſing of the quickſilver $\frac{1}{4}$ of an inch, if half ſo much, though the like degree of cold would make the water aſcend in a vulgar thermometer, though ſhorter, to the height of ſeveral inches. But this argument I alſo, on another occaſion, further diſplay and vindicate.

WHEREFORE I ſhall add one more, taken from the conſideration of theſe ſealed weather-glaſſes, that are deſcribed in this preſent Hiſtory of Cold. For in theſe the air does not ſhrink, but rather ſeems to be expanded, when the weather grows colder. If it be ſaid, that water being contracted by the cold, the air follows it, to prevent a vacuum; I anſwer, that thoſe, that ſay this, ſhould explain why, whereas in common weather-glaſſes the water aſcends to follow the air, in theſe the air muſt deſcend to follow the water; and why, ſince to avoid a vacuum, the one in common weather-glaſſes, and the other in ſealed ones, reſiſts contraction, nature does not rather make the air in common thermometers retain the extenſion, they conceive due to its nature, than put her ſelf to the double labour of ſuffering the air to be preternaturally condenſed, and compelling the water to aſcend contrary to its nature. But theſe arguments I will not urge ſo much as this other, that in our preſent caſe the above propoſed anſwer will by no means ſolve the difficulty. For if the water be really condenſed into leſs, and the air expanded into more ſpace, than they reſpectively poſſeſſed before; I ſee not, how a vacuum or a worſe inconvenience will be avoided. For I demand, ſince glaſs is granted to be impervious to air and water, (as indeed elſe nature would not need to make water aſcend contrary to its own tendency in a common weather-glaſs) what becomes of the body, that was harboured in the ſpace deſerted by the water upon its condenſation? which queſtion, thoſe that do not ſay any thing eſcaped away through the glaſs, or that any thing was annihilated, will not eaſily anſwer. But this is not all; for I further demand, when the air expands itſelf to follow the water, how by that expanſion of the air, a vacuum both *coacervatum* (as the old Epicureans ſpoke) and *interſperſum*, is avoided. For the aërial corpuſcles cannot advance into this ſpace deſerted by the water, without leaving either in whole or in part the ſpaces they filled before; ſo that by this remove an aërial corpuſcle only changes place, but does not adequately fill any more place than it did before. But if it be ſaid, that the ſame air, without any ſubſtantial acceſſion, may adequately fill more ſpace at one time than at another; if this, I ſay, be pretended, I ſhall not urge, that it appears not, why it were not more eaſy for nature in common weather-glaſſes, as well as in ſealed ones, to rarify the air, which they teach to be ſo very eaſily rarified and condenſed, than to make the heavy body of water to aſcend. For I may very well reply, that I ſcarce know any opinion in natural philoſophy, that to me ſeems more unintelligible, and more worthy to be confidently rejected, than this harſh hypotheſis of rarefaction. Of which I ſhould think it injurious to ſo judicious a philoſopher, as my Lord *Brouncker*, to endeavour here to manifeſt the abſurdity, though I had not in another place ſhewn it already. Defence againſt Linus, chap. 3.

The next opinion, we are to conſider touching the cauſe of the aſcenſion of water by cold in weather-glaſſes, is that of Mr. *Hobbes*, who, in the laſt chapter of his book *de Corpore*, ſect. 12. having premiſed a delineation of a common weather-glaſs, ſubjoins this explication:

In the ſixth and ſeventh articles of the 27th chapter (where I conſider the cauſe of cold) I have ſhewn, that fluid bodies are made colder by the preſſure of the air, that is to ſay, by a conſtant wind, that preſſeth them. For the ſame cauſe it is, that the ſuperficies of the water is preſſed at F, and having no place, to which it may retire from this preſſure, beſides the cavity of the cylinder between H and E, it is therefore neceſſarily forced thither by the cold, and conſequently it aſcendeth more or leſs, according as the cold is more or leſs increaſed. And again, as the heat is more intenſe, or the cold more remiſs, the ſame water will be depreſſed more or leſs by its own gravity, that is to ſay, by the cauſe of gravity above explicated.

But however the author of this explication, to prepare us to receive it, tells us, that however the above-mentioned phænomena *be certainly known to be true by experience, the cauſe nevertheleſs has not been diſcovered*; yet I confeſs, I think this newly recited aſſertion might as well have been placed after his explication, as juſt before it.

For firſt, whereas he remits us to the ſixth and ſeventh articles of the 27th chapter (for the reference is miſprinted) as containing the grounds of this explication, I muſt profeſs my ſelf far from being ſatisfied with the general theory of cold delivered in that chapter, as being partly precarious, partly inſufficient, and partly ſcarce intelligible, as I ſhall elſewhere have occaſion to ſhew. And as for what he particularly alledges in the ſixth and ſeventh articles of a conſtant wind, that preſſes fluid bodies, and makes them cold, beſides that that is proofleſsly affirmed, we ſhall anon have occaſion to mention an experiment, where water was not only much refrigerated, but turned into ice, though it were ſealed up in glaſs veſſels, and thoſe ſuſpended too in other glaſſes; wherein ſome of them had air about them, and ſome others were totally immerſed in unfreezing liquors; ſo that the water, that was ſealed up, was ſufficiently protected from being *raked* by the wind, as Mr. *Hobbes* conceit of the cauſe of freezing requires.

Secondly, I ſee no neceſſity, that the cold ſhould preſs up the ſuperficies of the water into the ſhank of the weather-glaſs, eſpecially ſince it is manifeſt, that the water will riſe with cold in a weather-glaſs kept in a ſtill place, and free from any ſenſible wind. Beſides that it ſhould be proved, and not barely affirmed, that an inſenſible motion deſerves the name of wind, and that ſuch a one is the cauſe of the refrigeration of water; and it ſhould be alſo ſhewn, how this wind comes to be able to raiſe the water, and that to the height of many inches more in one part of the ſuperficies than in another. Beſides all this, I ſay, we find by experience, that water poured into a bolt-head, till it have filled the ball, and reached a good way into the ſtem, will, upon a powerful refrigeration, ſhort of freezing, (which is the caſe of water in weather-glaſſes, when the air grows colder) manifeſtly ſhrink into a narrower room, inſtead of being impelled up higher in the pipe. And if in an ordinary weather-glaſs, with a long ſhank, you apply a mixture of ice or ſnow, and ſalt to the bolt-head, the water will readily aſcend in the ſhank to the height of divers inches, which, how it will be explained by Mr. *Hobbes*'s hypotheſis, I do not well ſee.

Sect. 11. of the ſame 30th chapter.

THIRDLY, I wonder he ſhould tell us, that the reaſon, why the preſſed water aſcends into the ſhank of the weather-glaſs, is, becauſe it hath no other place, into which it may retire from the preſſure of the wind; ſince he, rejecting a vacuum, and affirming the world to be every where perfectly full, ſhould not, methinks, have ſo ſoon forgotten, that in the very paragraph or ſection immediately preceding this, himſelf had told us, that he *cannot imagine how the ſame place can be always full, and nevertheleſs contain ſometimes a greater, ſometimes a leſs quantity of matter; that is to ſay, that it can be fuller than full.* So that I ſee not, why the water ſhould find more room to entertain it, in the cylindrical cavity of the weather-glaſs already adequately filled with air, than other where. And in the ſealed weather-glaſſes we have above been mentioning, and wherein the water deſcends with cold, it will be very hard for Mr. *Hobbes* to make out the phænomenon according to his doctrine. Beſides that his explication gives us no account of the condenſation of the air by cold in ſuch weather-glaſſes, as thoſe, wherein the water deſcends with cold and riſes with heat.

FOURTHLY and laſtly, whereas Mr. *Hobbes* takes notice of no other cauſe of the depreſſion of water in weather-glaſſes by heat, but its own gravity, he ſeems to have but ſlightly conſidered the matter. For though, in ſome caſes, the gravity of the water may ſuffice to depreſs it, yet, in other caſes, that gravity alone will by no means ſerve the turn, but we muſt have recourſe to the expanſive motion or ſpring of the air included in the cavity of the glaſs. For if you place a thermometer with a large ball, wherein the water aſcends but a little way into the ſhank, in a window expoſed to the warm ſun, you will often perceive the ſurface of the water in the pipe to be a good deal lower than that of the water on the outſide of the pipe; which ſhews, that this depreſſion proceeds not from the bare ſinking of the water, but from its being thruſt down by the preſſure of the incumbent air; ſince the water's own weight would make the internal water fall but to a level with the ſurface of the external water, and not ſo much beneath it. And for further proof, you may, by keeping ſuch a weather-glaſs long enough in the hot ſun, bring the air ſo far to expand itſelf, as to drive the water out of the ſhank, and break through the external water in divers conſpicuous bubbles, after whoſe eruption the remaining air being again refrigerated by the removal of the weather-glaſs into a cooler place, the loſs of that part of the air, that eſcaped away in bubbles, will make the water aſcend higher in the ſhank, than in the like degree of cold it would formerly have been impelled. And thus much may ſuffice to ſhew the unſatisfactorineſs of Mr. *Hobbes*'s conceit.

THE third and laſt opinion we ſhall mention, is that of ſome ingenious modern naturaliſts, who acknowledging, that the air has a weight, (which Mr. *Hobbes* alſo does in effect admit, though he make not ſo good uſe of it as they) do by that explicate the aſcenſion of water in weather-glaſſes; teaching, that the cold of the ambient air making the included air ſhrink into far leſs room than it poſſeſt before, the water in the ſubjacent veſſel is, by the weight of the incumbent air, which preſſes on it more forcibly in all the other parts of its ſurface, than it is preſſed up in that included in the ſhank, impelled up into that part of the ſhank, which was newly deſerted by the ſelf-contracting air.

BUT though this account be preferable by far to thoſe, which we mentioned before it, and though it be not only ingenious, but, as far as it reaches, true; yet to me I confeſs it ſeems not ſufficient, and therefore I would ſupply what is defective, by taking in the preſſure (and in ſome caſes the ſpring) of the external air, not only againſt the ſurface of water, (for that the newly mentioned explication likewiſe does) but alſo againſt the internal or included air. For the recited hypotheſis gives indeed a rational account, why the water is impelled into the place deſerted by the air; but then ſuppoſes, that the air is made to contract it ſelf by cold alone, when it makes room for the water, that ſucceeds in its place; whereas I am apt to think, that both the effects may proceed, at leaſt in great part, from the ſame cauſe, and that the preſſure of the contiguous and neighbouring air does, according to my conjecture, eminently concur to reduce the cooled air, ſhut up in the weather-glaſs, into a narrower ſpace. This it does in common weather-glaſſes, becauſe the ambient air retains the whole preſſure it has, upon the account of its weight; whereas the internal air, by its refrigeration, even when but equal to that of the external air, loſes part of the preſſure it had upon the accounts of its weakened ſpring.

BUT this, as I newly intimated, is not the ſole account, upon which the air may in ſome ſorts of weather-glaſſes impel up the water, and contribute to the condenſation of the air incumbent on the water. For in ſome circumſtances (one or two of which we ſhall produce by and by) it may ſo happen, that the reſt of the air, that bears up the water to be raiſed, will not be ſo much refrigerated, as the included air, that is to be condenſed; and conſequently the other air will have a ſtronger ſpring, than this laſt mentioned air will retain, and therefore the former will have a greater preſſure, than the latter will be able to reſiſt.

WE ſhall not now examine, whether the ſpring of the air depend upon the ſpringy ſtructure of each aërial corpuſcle, as the ſpring of wool does upon the texture of the particular hairs it conſiſts of, or upon the agitation of ſome interfluent ſubtile matter, that, in its paſſage through the aërial particles, whirries each of them about, or upon both theſe cauſes together, or upon ſome other differing from either of them: but this ſeems probable enough, that as, when air, being ſealed up in a glaſs, is afterwards well heated, though it acquire not any greater dimenſions, as to ſenſe, than it had before, yet it has its ſpring much increaſed by the heat; as may appear, if the ſealed tip be broken under water, by the eruption of bubbles, by the endeavour of the impriſoned air to expand itſelf: ſo upon the refrigeration of the air, ſo ſealed up, though the additional ſpring (if I may ſo ſpeak) which the heat gave it, will be loſt upon the receſs of that heat, or as ſoon as the effect of that heat is deſtroyed, yet there will remain, in the included air, a conſiderable ſpring, and ſufficient to make it as well fill (at leaſt as to ſenſe) the cavity of the ſealed glaſs, as it did when its ſpring was ſtronger. And proportionally we may conceive, that though cold, at leaſt ſuch as we meet with in this climate of ours, does make the ſpring of an included parcel of air weaker than it was before the refrigeration of that air, yet it may not make it ſo much weaker, but that the aërial corpuſcles may be kept ſo far extended, as not at all (or ſcarce ſenſibly) to quit the room they poſſeſſed before, in caſe there be not, contiguous to them, any other body, which, by its preſſure, endeavours to thruſt them inwards, and ſo make them deſert part of that ſpace. Which clauſe I therefore add, becauſe, that if the caſe propoſed do happen, it is obvious to conceive, that the weakened ſpring of the air cannot retain ſo much force to reſiſt an external preſſure, as it would have, if the cold had not debilitated it; and conſequently this cooled air muſt yield and ſuffer itſelf to be condenſed, if it come to be expoſed to a preſſure, to which it was but equal before its being weakened. And ſuch in common weather-glaſſes is the preſſure, that is conſtantly upon the ſurface of the water without the pipe, upon the account of the gravity of as much of the air or atmoſphere as comes to bear upon it.

Having thus explained our conjecture, we will now proceed to the experiments we made to countenance it, as we find them entered in our looſe notes.

In one of which, I find what follows:

We took a phial capable of containing five or ſix ounces of water, and having filled it almoſt half full with that liquor, we inverted into it a glaſs-pipe of about ten inches long, and much bigger than a large ſwan's quill, ſealed at one end, and at the other filled top-full with water; ſo that the open orifice being immerſed under the veſſel'd water (of the phial) there remained no air at the top of the pipe. Then, as much of the orifice of the phial's neck, as was not filled by the pipe, being carefully cloſed with cement, that no air could get in or out, the phial was placed in ſnow and ſalt, till the veſſel'd water began to freeze at the top and bottom; and, according to our expectation, we found, that, notwithſtanding this great degree of infrigeration of the air in the phial, the water in the pipe did not at all deſcend: ſo that either the air did not ſhrink by ſo great a cold, or the water, whether to avoid a vacuum, or otherwiſe, did not remove out of the pipe to poſſeſs the place deſerted by the refrigerated air.

Afterwards we endeavoured to repeat the experiment with the ſame glaſſes; but having had occaſion to be abſent a little too long (though not very long) we found, at our return, the upper and ſealed part of the pipe beaten out, which we ſuppoſed to have been done by the intumeſcence of the water in the phial upon its glaciation.

Wherefore we faſtened into the ſame phial another pipe, ſome inches longer than the former, and drawn very ſlender at the ſealed end, that it might eaſily be broken there; and having ſet the phial to freeze, as before, without finding the water to deſcend in the pipe, we did, with a forceps, break off the ſealed end, that the outward air might come to preſs upon the ſuſpended water, and, by it, upon the cooled air in the phial; whereupon, as we expected, the water was ſwiftly depreſſed, by our eſtimate, eight or ten inches, but not ſo low by a pretty deal, as the ſurface of the water in the phial.

After this, by rarifying the air in the vial, and by blowing into it through the pipe, the water was raiſed within about half an inch of the top of the pipe, whoſe ſlender end being ſealed, the phial was again placed in ſnow and ſalt; but the ſpring of the air at the top, which was rarified before, was, by refrigeration, ſo weakened, that it was unable ſenſibly to depreſs the water; wherefore, breaking off the apex, as before, the upper air immediately drove it down divers inches.

OUR laſt trial therefore was, to leave in the ſame pipe about 3½ inches of air rarified as little as we could, and placing the phial in ſalt and ſnow, as before, we obſerved, that the air in the pipe did, upon the refrigeration of the air in the phial, expand itſelf very little, though the water in the phial were in part turned into ice; but upon breaking off the ſlender ſealed end, the outward air preſently depreſſed the water above two inches beneath the laſt level, and by removing the glaſs into a warmer room, we found, that the water aſcended a pretty deal above an inch higher than the ſame uppermoſt level, whereby we probably concluded our weather-glaſs to be ſtanch.

THUS much I find together in one place, among my promiſcuous collections: but after this, coming to have the conveniency of glaſſes ſo ſhaped as to be eaſily ſealed, I judged it fit to make uſe of ſome of them, to keep even the moſt ſuſpicious from objecting, that I ſhould alſo have made ſome trials with glaſſes, which being hermetically ſealed, would be ſure moſt accurately to hinder all immediate intercourſe betwixt the internal and external air. And I remember, that once we took a glaſs, like the bolt-head of a common weather-glaſs, ſave that the ſmall end was drawn very ſlender, for the more eaſy breaking of the apex: and into this glaſs a convenient quantity of water was poured, and then the glaſs being ſealed up at the ſharp end and inverted, the water fell down to that end, and poſſeſt its due ſpace in the pipe. Then the round end of the glaſs having a mixture of ſnow and ſalt applied about it, though the internal muſt needs have been thereby much refrigerated, (as will be readily granted, and may be gathered from divers of the experiments mentioned in theſe papers) yet we obſerved not the water manifeſtly to riſe. And though an attentive eye ſhould in ſuch a trial diſcern ſome ſenſible intumeſcence in the water; yet that may well enough proceed from ſome little expanſion of the aërial particles, which we have elſewhere ſhewn to be uſually latitant in common water, upon the diminution of the preſſure of the air above the water, cauſed by weakening that air's ſpring by the cold. But when we had, to compleat the experiment, broken the ſlender end of the glaſs under water, the included air, becoming then contiguous to that had obtained immediate intercourſe with that water, whoſe ſurface was every where preſt by a pillar of the external air that leaned upon it, the water was by the gravity of that outward air haſtily impelled into the cavity of the pipe (the ſpring of whoſe air was, as we ſaid, weakened by the cold) to the height, if I miſremember not, of ſeveral inches.

ANOTHER ſort of trial I remember we made after the following manner: We took glaſs-bubbles (blown with a lamp) ſome of about the bigneſs of a nutmeg, and ſome much greater; each of theſe bubbles we furniſhed with a very ſlender ſtem (often no bigger than a raven's quill) which was uſually divers, and ſometimes many inches long. Into this ſtem a drop or two of water being conveyed, might eaſily enough, by reaſon of the lightneſs of ſo little liquor, together with the ſlenderneſs of the cavity (which permitted not the included air to penetrate the water at the ſides, but rather impel up the intire body of it) be kept ſuſpended, and ſo betray very ſmall changes, (and much ſmaller than to be taken notice of by common weather-glaſſes) as to rarifaction and condenſation in the air it leaned upon. Now when in one of theſe inſtruments, if watching when the pendulous water was ſomewhat near the top of the ſtem, we nimbly applied to the orifice of that ſtem the flame of a candle, we could by that heat almoſt in a moment ſeal it up, by reaſon of the thinneſs of the glaſs, and the ſlenderneſs of the ſtem. And if then we placed the thus ſealed glaſs in a mixture of ſnow and ſalt, how much ſoever the air within the cavity of the ball muſt be, in all probability, refrigerated by this operation, yet it would ſcarce ſenſibly,

See more concerning theſe weather-glaſſes in the firſt of theſe three diſcourſes.

and not at all conſiderably ſhrink; as we gathered from the pendulous waters remaining in the ſame place, or its falling at moſt but inconſiderably lower. But if then with a pair of ſciſſars or otherwiſe, we dextrouſly broke off the ſealed end of the ſtem, and thereby expoſed the internal refrigerated, to the preſſure of the external air, the water immediately would be haſtily thruſt down, ſometimes divers inches below its former ſtation, and ſometimes quite into the cavity of the round end of the glaſs. To which we ſhall add, that not only, when theſe thermometers were ſealed, neither the uſual degrees of cold, nor thoſe of the heat in the ambient air would at all conſiderably depreſs or raiſe the pendulous water, which, if the glaſs were not ſealed, would, as we formerly noted, ſhew it ſelf wonderfully ſenſible of the mutations of the air, as to thoſe two qualities: But we ſometime purpoſely tried, that though upon the refrigeration of the formerly rarified air in the glaſs, the pendulous water were deſcending faſt enough, yet if even then we nimbly ſealed up the open orifice of the ſtem (which may eaſily be done in a trice) the deſcent of the water would be preſently ſtopt, and it would ſtay either juſt in, or very near the ſame part of the ſhank, wherein it chanced to be, when by ſealing of the glaſs it came to be fenced from the preſſure of the atmoſphere; and in that place it would continue till the ſealed end were broken off. For then in caſe the ambient air were as cool, as it was when the glaſs was ſealed, the water would for the reaſon already given be further depreſt, according as the weakened ſpring of the inward rarified air was more or leſs remote from an equality to the preſſure of the ambient air.

BESIDES, for further trial, we took a large glaſs-egg with a long ſtem, which ſtem was purpoſely ſo bent, that it repreſented a glaſs-ſiphon, in whoſe ſhorter leg the glaſs was drawn very ſmall, that it might be the more eaſily firſt ſealed, and then broken.

See the figure among the reſt of the ſchemes.

THIS done, we got in a convenient quantity of water, which aſcended to a pretty height in both the legs of the bent glaſs, after which the ſhorter leg being nimbly ſealed after the manner hereafter to be mentioned, there remained a pretty quantity of air above the water in that ſhorter leg, which was purpoſely left there, that it might, by its ſpring, impel up the water in the longer leg upon the refrigeration of the air included in that longer leg. All this being done, the whole glaſs was ſo placed in a convenient frame, that the oval part of it was ſupported by the frame, beneath which the bended ſhank of the weather-glaſs did hang ſo, that a mixture of ice and ſalt might be conveniently laid upon this frame to ſurround and refrigerate the air included in the egg, without much cooling the air in the cylindrical part of the glaſs. The account, that I find of this trial in one of my notes, is this.

IN the greater bent egg, that was ſealed up with water, in both legs, upon the application of ice and ſalt to the ellipſis at a convenient time, the water in a longer leg aſcended a little, but not by our gueſs above a barley-corn's length, if near ſo much, and about four inches of air (as I remember) that were left in the ſhorter leg, expanded itſelf (to ſenſe) as much; but as ſoon as I broke off the ſlender wire, wherein the ſhorter leg ended, the external air ruſhing in made the water riſe about two inches and a quarter in the longer leg, and then, there not being water enough, broke through it in many bubbles.

THUS far the note, to which I ſhall only add, that in this caſe the aſcenſion of the water in the longer leg cannot be attributed to the weight of the air in the ſhorter leg, that being, I know not how much, too ſmall to lift up ſo much water, but to the ſpring of that air: and alſo that we need not marvel, the expanſion of that air ſhould be ſo ſmall, ſince ſome of the experiments, hereafter to be related, will ſhew us, that the refrigeration of the air in ſuch trials (as that newly recited) does not weaken the ſpring of it any thing near ſo conſiderably as one would expect. So that the air in the longer leg could yield but a very little to that in the ſhorter leg, eſpecially ſince the ſmallneſs of this laſt named proportion of air made its ſpring to be more eaſily and conſiderably weakened by a ſmall expanſion.

THUS far our paradoxical diſcourſe, which contains divers particulars, that, being added to the conſiderations, whereunto we have (by way of appendix) ſubjoined it, might afford us ſeveral reflections: but having dwelt too long on one ſubject already, we ſhall now conclude with this, upon the whole matter;

THAT there is ſomewhat or other in the buſineſs of weather-glaſſes, which (I fear) we do not yet ſufficiently underſtand, and which yet, I hope, that by other trials and more heedful obſervations we ſhall diſcover.

## *The Paper, that was prefixed (by way of a ſhort prefatory Addreſs) to the enſuing Hiſtory of Cold, when being to be brought in, and preſented to the* Royal Society, *it was put into the hands of its moſt worthy Preſident, the Lord Viſcount* Brouncker, *was as followeth.*

My Lord, Little Chelſea, Feb. 14, 1662. S. A.

THE time your lordſhip and the ſociety appointed me for the bringing in of my papers, concerning cold, is ſo very ſhort, that to give you the fruits of my obedience as early as you are pleaſed to require them, I muſt preſent them you very immature, and I ſhould ſay very unfit for your peruſal, if you were not as well qualified to ſupply deficiencies and imperfections as to diſcern them. For of all the old obſervations, I made divers years ago, in order to the hiſtory of cold, I have not yet found enough, to fill up one ſheet of paper: and as for thoſe, I made the laſt froſty ſeaſon, beſides that I was ſeveral times diverted by avocations diſtracting enough, the ſharpneſs of the weather, which gave me the opportunity of making ſome experiments, brought me an indiſpoſition, which by forbidding me to be often, and ſtay long in the cold air, hindered me from making divers others; and (which is worſt of all) whilſt I was confined to a place, where I wanted divers glaſſes, and other inſtruments I would have employed, the ways both by land and water were ſo obſtructed by the ſnow and ice, that I could not ſeaſonably procure them from *London*, and was thereby reduced to leave ſeveral trials, I ſhould have made, either unattempted, or unproſecuted. But leſt you ſhould think, that what I intend only to excuſe my unaccurateneſs, is meant to excuſe my pains, I ſhall without further apology apply my ſelf to do what the ſhortneſs of the time will allow me, which is little more, than to tranſcribe into this hiſtorical collection moſt of the particulars, which your lordſhip's commands exact, though haſte will make me do it in the very words, for the moſt part, that I find them, in a kind of note-book, wherein I had thrown them for my own private uſe; which I the leſs ſcruple now to do, not only becauſe the haſte, that exacts from me this way of writing, may ſerve to excuſe it in me, but that it may the better appear, how little I had deſigned to wreſt or byaſs them to any pre-conceived hypotheſis.

## THE

# EXPERIMENTAL HISTORY OF COLD BEGUN.

## TITLE I.

### *Experiments touching bodies capable of freezing others.*

TO go methodically to work, we ſhould, perhaps, begin with conſidering, what ſubjects are capable, or not capable of harbouring the quality we are to treat of; and to invite us to this, it ſeems probable enough, that among the bodies, we are converſant with here below, there is ſcarce any except fire, that is not, at ſome time or other, ſuſceptible of actual cold (at leaſt as to ſenſe). And even concerning fire it ſelf, till that difficulty be clearly determined, which we have elſewhere ſtarted; namely, whether fire be not, as wind, (at leaſt like ſuch as is made by air blown out of a pair of bellows) rather a ſtate of matter, or matter conſidered whilſt it is in ſuch a kind of motion, than a diſtinct and particular ſpecies of natural bodies, there may remain ſome doubt; ſince we ſee, that bodies, which may be either in a moment, as gunpowder, or (as far as ſenſe can judge) totally, as high rectified ſpirit of wine, turned into fire, may yet immediately before their accenſion, be actually cold: and as to gunpowder, preſently after accenſion, its ſcattered parts caught in cloſed veſſels will alſo appear cold to the touch. But ſuch things neverthleſs we muſt not now inſiſt on, partly becauſe it requires the reſolving of a ſomewhat difficult queſtion, which more properly belongs to the conſiderations about heat, where we have already handled it; partly becauſe our deſign in the following collections was not ſo much to gather and ſet down obſervations, that were obvious to any, that was furniſhed with a mediocrity of attention, as experiments purpoſely made in order to the hiſtory of cold; and partly too, becauſe in this collection, though we do, as occaſion ſerves, take notice of experiments and phænomena, that relate to cold in general, or indefinitely; yet our chief work has been to find out, and deliver, the phænomena of congelation, or of that intenſe degree of cold, which either does freeze the bodies it works upon, or at leaſt were capable of turning common water, fitly expoſed to it, into ice. And this may ſerve for a general advertiſement about the enſuing papers; and conſequently having premiſed it, we ſhall without any further preamble proceed to the ſetting down ſuch things, as we have tried and obſerved concerning thoſe matters; beginning with thoſe, that belong to the title prefixed to the firſt part, or ſection, of our hiſtory.

1. THE bodies, that are cold enough to freeze others, are in this climate of ours but very few, and among the moſt remarkable is a mixture of ſnow and ſalt, which, though little known, and leſs uſed here in *England*, is in *Italy* and ſome other regions much employed, eſpecially to cool drinks and fruits, which men may eaſily do, by burying, in this mixture, glaſſes, or other convenient veſſels, filled either ſolely with wine, or other drinks, or elſe with water, that hath immerſed in it the fruits to be refrigerated.

2. THE circumſtances we are wont to obſerve in making and employing this mixture, we ſhall hereafter in due place deliver; and therefore here we ſhall only take notice, that we could not find upon ſome trials, that ſuch glaſſes filled with water, as would be frozen eaſily enough by this mixture of ſnow and ſalt, would be in like manner frozen, in caſe we employed ſnow alone, without mingling any ſalt with it. I deny not, that it is very poſſible, that in very cold countries, as well ſnow as beaten

ice may freeze water poured into the intervals of its parts. But there is great odds betwixt water ſo intermingled with ice or ſnow, and only ſurrounded with it in a veſſel, where the water is, as it were, in one intire body, and of a comparatively conſiderable thickneſs: and there is alſo a great difference betwixt the degrees of coldneſs in the air of frigid regions, and of *England*. And perhaps too there may be ſome diſparity betwixt the degrees of coldneſs of ice and ſnow in thoſe climates, and in ours. And we muſt have a care, that in caſe a phial full of water buried all night ſhould freeze, we aſcribe not the effect to the bare operation of the ſnow, which may be (entirely, or in great part) due to the coldneſs of the air, which would, perhaps, have performed the effect without the ſnow.

3. BUT though ſnow and ſalt mixt together will freeze water better than ſnow alone, yet we muſt not think, that there is any ſuch peculiar virtue in ſea-ſalt, to enable ſnow to freeze, but that there are divers other ſalts, each of which concurring with ſnow is capable of producing the like effect. For we found upon trial, that we could freeze water without the help of ſea-ſalt, by ſubſtituting in its place, either nitre, or alum, or vitriol, or ſal armoniac, or even ſugar; for either of thoſe being mingled with a due proportion of ſnow, would ſerve the turn, though they did not ſeem equally to advance the congealing power of the ſnow; nor ſcarce any of them did do it ſo well as ſea-ſalt. But of this elſewhere more.

4. WHEN we had made the newly-mentioned trials, ſome particular conjectures, we have long had about the nature of ſalts, invited us to try, whether, notwithſtanding the comminution and conſequent change produced in ſalts by diſtillation, the ſaline corpuſcles, that abound in the diſtilled liquors of thoſe concretes, as well as in their ſolutions, would not likewiſe, by being mixt with it, enable ſnow to freeze water, at leaſt in ſmall and ſlender glaſſes? This we firſt went about to try with good ſpirit of ſalt: but we found, as we feared, that though it made a ſufficiently quick diſſolution of the ſnow it wrought upon, yet its fluidity hindered it from being retained long enough by the ſnow, to the bottom of which it would fall, before they had ſtayed ſo long together, as was requiſite to freeze ſo much as a little eſſence-bottle full of common water.

5. WHEREFORE we bethought our ſelves of an expedient, whereby to try the operation, not only of thoſe ſpirits, but of divers other bodies, which were unapt for a due commixture of ſnow after the way newly mentioned, or of which we had too little, or valued them too much, to be willing to ſpend quantities of them upon theſe trials. And this way (that remains to be mentioned) we ſomewhat better liked, becauſe the experiments made according to it would alſo prove experiments of the tranſmiſſion of cold through the extremely cloſe body of glaſs.

AND even in this way of trying, we did at firſt meet with a diſcouragement, which, leſt it ſhould happen to others, we ſhall here take notice of; namely, that having put a convenient quantity of ſnow into a ſomewhat thick green glaſs phial, though we copiouſly enough mixt with it a ſomewhat weak ſpirit of ſalt, (being loth to employ the beſt we had) and having well ſtopt the veſſel, did carefully ſhake together, and thereby agitate the mixture in it, yet the glaſs appeared only bedewed upon the outſide, without having there any thing frozen. But ſuſpecting, that the thickneſs of the glaſs might be that, which hindered the operation of the included mixture, we put ſnow and a convenient proportion of the ſelf-ſame ſpirit of ſalt into a couple of thin phials, one of which we cloſed exactly, and the other negligently, and having long ſhaken them, we found, that what adhered to them on the outſide, was (though but ſomewhat faintly and thinly) frozen.

6. AND, as to this ſort of experiments, we ſhall here obſerve once for all, that the ſnow or ice included, together with the ſaline ingredient (whatever that were) was always thawed within the glaſs; and that conſequently, it was the condenſed vapour of the air, or other liquor that adhered to the outſide of the glaſs, which was turned into ice, which is the reaſon, why in mentioning theſe experiments we often uſe the word freeze in a tranſitive ſenſe, to ſignify the operation of the frigorifick mixture upon other bodies.

7. THIS premiſed, let us proceed to relate, that we afterwards took oil of vitriol, and mixing it with ſnow in ſuch another phial as that laſt mentioned, we found its freezing power far greater than that of ſpirit of ſalt. And leſt it ſhould be pretended, that in theſe experiments the cold was not tranſmitted through the ſides of the glaſs, but that the air within the phial, highly refrigerated by the mixture, did upon the account of their free intercourſe enable the air contiguous to the outſide of the phial to freeze the dew it met with ſticking on it; we proſecuted the experiments with the addition of this circumſtance, that on ſeveral occaſions we ſealed up the phial, that contained the ſnow and the other frigorifick body it was mixed with, and afterwards by the help of this mixture froze the externally adhering moiſture.

8. HAVING then, according to this way, ſuſtituted ſpirit of nitre for oil of vitriol, or ſpirit of ſalt, we found, that it froze yet more powerfully than either of thoſe two liquors, and continued to do ſo in thoſe parts of the outſides of the glaſs, that were adjacent to the included ſnow, till that ſnow was almoſt totally reſolved into a liquor. This we tried both in a thin ſealed glaſs, and in a pretty thick glaſs ſtopped only with a cork.

9. AFTERWARDS we ſucceſsfully enough tried the experiment with ſpirits leſs acid, as not only with ſpirit of vinegar, but with ſpirit of ſugar; I mean the red empyreumatical ſpirit forced over in a retort, which mixed with ſnow, according to the manner of the experiment, did at length freeze the externally adhering moiſture. But the films of ice were very thin, and very apt quickly to diſappear.

10. HAVING thus made a number of trials with acid ſpirits, we thought fit to make ſome with urinous ſpirits, that abound in volatile ſalt; and accordingly having mixt ſpirit of urine and ſnow in an open phial, and agitated them, we found, that the external moiſture did diſcernably, though not very ſtrongly, freeze.

BUT with ſpirit of ſal armoniac drawn from quick-lime (according to the way I have delivered in another treatiſe) the operation was quick and powerful enough.

11. HAVING tried to freeze water with acid, and with volatile ſpirits apart, we thought it not amiſs to try what they would do both together; and accordingly pouring upon ſnow both ſome ſpirit of urine, and a little oil of vitriol, and ſhaking them into the ſnow in an open phial, we found, that the mixture did freeze, though the glaciation, in this caſe produced, were very languid.

12. HAVING thus tried ſalts diſengaged from their groſſer parts, or ſhattered into corpuſcles by diſtillation, we made ſome trial likewiſe with groſſer ſalts, as with ſal-gem, with a ſublimate made with common ſublimate and ſal armoniac, nay, and with both loaf and kitchen ſugar, with all which, among the like bodies, that I can now remember, the experiment ſucceeded well enough: alſo a very ſtrong ſolution of pot-aſhes, mixed with ſnow in an open ſingle phial, did freeze, but that very faintly. And both a very ſtrong ſolution of very pure ſalt of tartar, and (at another time) a ſtrong ſolution of pot-aſhes, being the one as well as the other, mixed and agitated with ſnow in a ſingle phial, produced films of ice (though thin ones) on the outſide of the glaſs.

13. After this, we thought fit to make a trial of another kind, of which I find this account among my notes. We filled a ſingle phial with ſnow, and then poured into it a convenient proportion of a ſtrongly ſweet ſolution of minium in ſpirit of vinegar, and having ſhaked the mixture together, we found, that this ſweet ſugar of lead did, as well as acid and alcalizate ſalts, excite the cold of the ſnow ſo much, as to produce films of ice on the outſide of the glaſs: but a parcel of the ſame ſolution, being for divers hours kept in ſnow and ſalt, was not thereby frozen.

In order to the diſcovery of ſome hints of the account, upon which the abovementioned mixtures were more intenſely frigefactive than ſnow alone, we ſealed up a ſingle phial full of ſnow unmingled with any other ingredient, and found it to thaw much more ſlowly, than any of thoſe parcels of ſnow, which we had mixt with ſalts or ſpirits.

In proſecution of this conjecture, we ſhall add, that, for aught we could find, by divers trials, no ſalt, that helps not the ſnow to diſſolve faſter than elſe it would, did enable it to produce ice, though uſually it did produce dew on the outſide of the phial, that contained the mixture; and accordingly, neither cryſtals of tartar, nor borax, both beaten to powder, nor, which is more, (conſidering what we lately noted of the effects of another ſort of ſublimate) would ſublimate enable the ſnow to freeze; as well the powder of ſublimate as that of borax, and that of tartar, lying for a great while in the ſnow undiſſolved.

14. Belonging to this matter, I find among my papers alſo this note.

[Water of quick-lime (made by quenching ſtore of unſlacked lime in common water) twice tried, would not make ſnow freeze, perhaps becauſe though the water were kept ſtopt, yet the liquor having been kept in the glaſs a twelve-month, and more; probably the ſpirits may have flown away, which I find, by inquiring of one that drinks much lime-water, that it abounds with, when freſh, and grows deſtitute of a while after: and poſſibly alſo the badneſs of the lime was the cauſe, why being mingled with ſnow it would not freeze, though all the phials, that did not freeze, did yet gather ſtore of dew on the outſides (perhaps becauſe of the ſnow, whoſe melting alone may ſuffice to produce that effect.]

15. It may ſeem ſomewhat more ſtrange, that diſtilled oil of turpentine; which is ſo hot and fiery a liquor, ſhould not enable ſnow to freeze; but this agrees not ill with the conjecture lately mentioned, for it will hereafter appear, that in oil of turpentine ice diſſolves ſlower than in divers other liquors, without excepting common water itſelf..

16. And yet notwithſtanding the bad ſucceſs of this trial, we were not diſcouraged from making another with ſpirit of wine; for though, according to the common opinion of chymiſts and phyſicians, it be a meer vegetable ſulphur, yet we, that have elſewhere ventured to aſcribe ſome ſuch operations to it as chymiſts would have belong to ſaline liquors, did not ſcruple to ſeal up, in a ſingle phial almoſt filled with ſnow, a convenient quantity of the pure ſpirit of wine, (drawn off from quick-lime, the better to dephlegm it) and of this mixture we found the operation more powerful than any of thoſe we have formerly mentioned: for the freezing virtue of this did not only laſt long, both in the ſealed ſingle phial, and in another that was open, but the incloſed mixture preſently cruſted the outſide of the glaſs (or of the neck, if it were made to fill that) with ice, which might be taken off in flakes of good breadth, or in pieces of good thickneſs. Nay, it preſently froze urine into figured ice, which might be taken off in ſcales.

17. This laſt circumſtance puts me in mind of another experiment, whereby we tried by a vigorous mixture of ſnow, and ſome choice ſpirit of nitre, we had met with, to freeze liquors of more difficult conglaciation than fair water.

WE took then ſome ſnow, and mingled with it ſome of the newly mentioned ſpirit of nitre in ſo lucky a proportion, that it froze very vigorouſly and very ſuddenly; inſomuch, that once almoſt as ſoon as it was ſet to the ground, it froze the phial to the floor it was ſet on, and the outſide of the glaſs, that contained this mixture, we wetted with ſpirit of vinegar, which was frozen into pretty thick ice, but yet (not quite to forget that circumſtance) retaining the ſalt taſte of ſpirit of vinegar. And though this mixture would not diſcernibly freeze ſpirit of nitre on the outſide, yet it tranſmitted cold enough to freeze weak ſpirit of ſalt, and to give us the pleaſure of ſeeing ſome ſaline liquors preſently turned into figured ice; as not only the laſt mentioned ſpirit exhibited ſome little (as it were) ſaline icicles croſſing each other, and quickly vaniſhing, but (which was far prettier) having often obſerved, that ſal armoniack being diſſolved in water, and the ſolution being put very ſlowly to evaporate part, but not too much, away, the remaining liquor would, in the cold, ſhoot into parcels of ſalt very prettily figured, ſome of them reſembling combs with teeth on both ſides, and others reſembling feathers: having obſerved this, I ſay, and being deſirous to try, whether the ſpirit of ſal armoniack, diſtilled by the help of quick-lime, being put to congeal on the outſide of a glaſs, would not afford a reſemblingly figured ice; we found upon trial, both that the mixture was able to freeze that ſubtile ſpirit, and alſo, that it ſhot into branches almoſt like thoſe, exhibited by ſuch ſalts undiſtilled. And it was not unpleaſant to behold, how upon inclining the glaſs ſo, that the freezing mixture reſted a little, near any part of the ſpirit, this liquor would ſhoot into ſuch branches as we have been ſpeaking of, ſo nimbly, that the eye could plainly diſcern them, as it were, to grow, and haſtily overſpread the ſurface of the glaſs, but thoſe branches were wont quickly to vaniſh.

I HAD almoſt forgot to mention, that I tried the freezing with ſnow, and divers fermented liquors undiſtilled, inſtead of ſpirit of wine; and though the experiments ſucceeded not with ſmall beer, much leſs with water, yet there was a glaciation, though but ſlight, produced not only by the addition of wine, but even by that of moderately ſtrong ale.

18. HAVING obſerved, that the liquors and other bodies, that aſſiſted the ſnow to freeze, were generally ſuch as haſtened its diſſolution, we thought it not altogether unworthy the trial, to examine, what would be the event of procuring a ſpeedy diſſolution of the ſnow, by ſubſtituting bodies actually warm, inſtead of potential hot ones: of this ſort of trials, I find among my notes theſe two regiſtred.

[1. INTO a ſingle phial almoſt filled with ſnow, there was poured a pretty quantity of well-heated ſand, that it might diſſolve the ſnow in many places at once, without heating the ambient air, or the outſide of the glaſs: but though the ſolution of the ſnow ſeemed to ſucceed well enough upon the ſhaking of the veſſel, yet the outſide of the glaſs was only bedewed, not frozen.

2. INTO another ſingle phial almoſt filled with ſnow, we poured ſome water, which we judged of a convenient warmth, and we poured it in by a funnel, that had but a ſlender orifice beneath, that the warm water might fall into the middle of the ſnow, without running to the ſides; and taking a convenient time to ſhake the glaſs, we did by this way produce a very conſiderable degree of cold, and much dew on the outſide, but were not ſatisfied, that any of that dew was frozen, though the ſucceſs would have invited us to have made further trials in greater glaſſes, if we had had any more ſnow at hand.]

WHEREFORE this experiment is to be further and more artificially tried.

19. It is a common tradition, not only among the vulgar, but (I preſume, upon their account) among learned men, that the oftentimes variouſly, and ſometimes prettily enough figured hoar froſt, which is wont to appear upon glaſs windows in mornings, preceded by froſty nights, are exſudations, as it were, that penetrating the glaſs windows, are, upon their coming forth to the cold external air, frozen thereby into variouſly-figured ice. How groundleſs this conceit is, may be eaſily diſcovered, if men had not ſo lazy a curioſity, as not to try (which they may do in a moment, and without trouble) whether the ice be, according to the tradition, on the outſide of the window, and not contrary to it on the inſide, where indeed it is generated of the aqueous corpuſcles, that ſwimming up and down in the air within the room, are by the various motion, that belongs to the fluid bodies as ſuch, brought to paſs along the window, and there by the vehement cold of the neighbouring external air, communicated through the glaſs, condenſed into dew, and frozen into ice.

20. And becauſe divers modern naturaliſts have taught (I think erroneouſly) that glaſs is eaſily enough pervious, not only to air, but to divers ſubtile liquors, leſt the favourers of this doctrine ſhould object, that we have ill aſſigned the natural cauſe of the ice appearing on the outſide of the glaſs in the former experiments, which, according to them, may rather proceed from the ſubtler (but yet viſible) parts of the exceſſively cold mixture of the ſnow and ſaline bodies penetrating the pores of the glaſs, and ſettling on the outſide of it: to obviate this objection, I ſay, and to confirm what we have taught in another treatiſe about the wandering of ſtore of aqueous vapours through the air, we will add the following experiments, purpoſely made to evince theſe truths.

21. At one time four ounces and a quarter of a mixture of ice and ſalt, being incloſed in a phial, and thereby enabled to condenſe the vapours of the ambient air, was by their acceſſion increaſed 12 grains.

Another time a phial, wherein ſnow (weighing two ounces ſix drachms and an half) was ſuffered to condenſe the vapid air, the dew, that partly adhered to it, and partly fell from it, made the whole weigh four grains more than the phial did, when it was firſt put into the ſcale; in which ſcale we found ſome water flowing from the dew, which gave that increaſe of weight. And here let me add by the way, that the tip of this ſealed phial being broken under water, ſucked in a conſiderable quantity of it: whether, becauſe of ſome little rarefaction of the air included in the ſealing, or becauſe of the infrigidation of that air by the ſnow, or for both theſe reaſons, or any other, I ſhall not now diſpute.

22. But other experiments to the ſame purpoſe we made, wherein the increaſe of weight was more conſiderable; and that the way, we uſed, may be the better underſtood, and the concluſion built upon it the more undiſcuſſed, we will add a couple of trials, that we find among our notes concerning this matter.

[In a ſingle phial we ſealed up as much ſnow and ſalt, as afterwards, when melted, we found to weigh between five and ſix ounces; after a while, the ſalt beginning to melt the ſnow, the dew on the outſide began to congeal, and being rubbed off, the hoar froſt would quickly begin to come again. This phial for further trial being put into a pair of ſcales with a counterpoiſe, after a while, as the vapours, that wandered through the air in the warm room, happened to be detained more and more upon the outſide of the glaſs, and to be there frozen, the ſcale, wherein the glaſs was, began to be depreſt, and to ſhrink lower and lower; after which, by adding a little to the counterpoiſe, we reduced them again to an æquilibrium; and yet after a while, the ſcale, that held the phial, ſubſided again more and more, till the included ſnow was melted: ſo that to reduce the ſcales to their firſt æquilibrium, we were fain to add in all to the counterpoiſe a weight, which we eſtimated to be about eight or ten grains, (for we had then no great weights by us.) The phial being taken out, there appeared near half a ſpoonful of liquor in the ſcale it ſtood in, which proceeded from the thaw of the ice, that was generated about it. But in that part of the ſcale, which was covered with the convex part of the bottom of the glaſs, there appeared no wet.

A LIKE or ſmaller quantity of ſnow and ſpirit of wine being ſealed up in a ſingle phial, the outſide quickly appeared caſed with ice as high as the mixture reached within, and this phial alſo being counterpoiſed in a pair of ſcales, did by degrees depreſs the ſcale, that held it, till it had ſunk it very low, and about ſeven grains did but reduce the ſcales to an æquilibrium; but the ſcales being ſomewhat ruſty, we could not make the trials with that exactneſs we deſired.]

23. BUT at other times, when the experiment was more luckily, though not more carefully tried, with better ſcales, the increaſe of weight from the condenſed vapours of the air was ſomewhat more conſiderable; for I find in a ſhort note,

[THAT at one time a mixture of ſpirit of wine and ſnow, weighing three ounces and three quarters, afforded of condenſed vapours about 18 grains.

AND at another time a mixture of ſnow and ſal gemmæ, weighing three ounces and ſeventy grains, procured us an acceſſion of water weighing about 20 grains.]

## TITLE II.

### *Experiments and obſervations touching bodies diſpoſed to be frozen.*

1. IT were almoſt endleſs to try particularly, which bodies are or are not capable of congelation, and the degree of cold would alſo in ſuch experiments be (as near as men can) determined; becauſe many bodies will freeze in one degree of cold, that will not in another: wherefore we are willing to leave theſe trials to thoſe, that have more leiſure and opportunity to proſecute them, and ſhall only ſet down ſome, and thoſe ſomewhat various, that we may not leave this part of the Hiſtory of Cold quite unfurniſhed. And we muſt mention the fewer, becauſe, being in the country, we were not provided of divers of the bodies, which we ſhould have expoſed.

2. IN very cold ſnowy weather, we tried that (beſides common water) urine, beer, ale, milk, vinegar, and French and Rheniſh wine (though theſe two laſt but ſlowly) were turned into ice, either totally, or in part. But ſuch inſtances will poſſibly be thought too obvious to be inſiſted on; therefore I ſhall add, that not only we froze a ſtrong ſolution of gum arabick, and another of white ſugar in common water, but that we took alum, vitriol, ſalt-petre, and ſea-ſalt, and made of each of them in a ſingle phial as ſtrong a ſolution as we could; we alſo made a ſtrong ſolution of verdegreaſe in fair water (which was thereby deeply coloured) all theſe we expoſed to the cold air. The ſolution of alum, nitre and verdegreaſe froze without affording any notable phænomena, either in the figuration of the ice, or otherwiſe: of the ſolution of vitriol there remained, at the bottom of the glaſs, a pretty quantity unfrozen, and of a clear ſubſtance, whoſe colour was very high of the vitriol; whereas the upper part of the ſame ſolution differed very little in colour from common ice.

3. BUT becauſe it ſeems not ſo ſtrange, that theſe groſs ſorts of ſaline bodies ſhould be turned into ice, we thought fit to try, whether or no alſo divers ſalts, freed

from the groſſer parts of their concretes by the fire, were not likewiſe capable of congelation. We expoſed therefore ſpirit of vinegar in one ſmall glaſs, and ſpirit of urine in another, to an intenſe cold, and found, that not only the former, but the latter alſo froze.

4. We took likewiſe ſome of the fiery lixiviate ſalt of pot-aſhes, and a ſingle phial, in which we put, to two ounces of water, a drachm of the alcali, and expoſing it to a very ſharp air, we did, when we came to ſee the ſucceſs of the trial, find ice lying on the top in little ſticks (ſomething croſſing one another) almoſt like the cryſtals of rocked petre; and beſides theſe, that lay levelled, there were others, that ſhot downwards in very great numbers.

5. We alſo found, that oil of tartar per deliquium, or at leaſt a ſtrong ſolution of the fixt ſalt of tartar, though it ſeemed much to reſiſt the cold, yet it was once by ſnow and ſalt brought to congelation.

### *Appendix to the* II*d. Title.*

SINCE I wrote the preſent book concerning cold (expecting ſome of the appendices) having once had the opportunity of an hour's diſcourſe with an ingenious man, that not only lived ſome years in *Muſcovy*, but was, and is ſtill phyſician to the great monarch of that empire; and having likewiſe at other times converſed with navigators, and ſome other credible perſons, that had travelled either to *Greenland*, *Terra Nova*, or other gelid climates, I propoſed them divers queſtions; by their anſwers to which, I learned ſome particulars, which, together with others, that I have met with in voyages and other books, I think it not amiſs to annex by way of appendices to the foregoing, and ſome of the following ſections, or titles.

About the freezing of common expreſſed oils, I know not well what to determine; for that they may, by a very intenſe cold, be deprived of their fluidity, and be made capable of being cut into portions, that will retain the figure given them, my own trials invite me to believe: but whether ſuch oils will be turned into true (by which I mean) hard and brittle ice, is a queſtion ſcarce to be determined by any experiments we can make here in *England*, where we could not reduce oil-olive into ice. And for the relations of thoſe, that have lived in colder countries, I find them to diſagree: for when I aſked the lately mentioned doctor the queſtion, how far he had known oil congealed in *Muſcovy?* he anſwered me, that it did there freeze much harder than in our climate, but would not, that he had obſerved, be turned into true and perfect ice. On the other hand, I find the teſtimony of that ingenious navigator captain *T. James*, who relating the effects of cold he met with in the iſland, where he and his men were forced to winter, does in one place reckon oil among the liquors, ſuch as vinegar, and ſack, that even in their houſe was firmly frozen, and more expreſly elſewhere, "All our ſack (ſays he) vinegar, oil and every thing elſe, that was "liquid, was now frozen as hard as a piece of wood, and we muſt cut it with a "hatchet." Page 58. And *Olaus Magnus* ſpeaking of the fights, wont to be made upon the ice in the northern regions, *Glacialis congreſſus* (ſays he) *fit in laneis calcibus, non pellibus, aut coriis unctis: vis enim frigoris, quodcunque ſit unctuoſum, convertit in lubricitatem glacialem.* Olai Magni Gent. Sept. Hiſt. l. 11. c. 24.

There being a great ſimilitude in point of inflammability, and diſpoſition to mix with many ſubtile oleous bodies, betwixt ſpirit of wine and oil, and as great an affinity in divers other regards, betwixt that ſpirit and both aqueous and ſaline liquors, with which it will readily mix; I had a great curioſity to know, what kind of change would be produced in vinous ſpirits, in caſe they were expoſed to a cold great enough to work a viſible change in their texture. I therefore ſolicitouſly inquired of the *Ruſſian* emperor's lately mentioned phyſician, whether or no he had obſerved in *Muſcovy* any manifeſt change produced by cold in hot waters, and ſpirit of wine? To which he returned me this anſwer; that common aniſeed-water, and the like weak ſpirits, would be turned into an imperfect kind of ice; and that even the very ſtrong ſpirits, though they would not be turned into ice, would be turned into a kind of ſubſtance like oil.

## TITLE III.

### *Experiments touching bodies indiſpoſed to be frozen.*

1. WE found many liquors, whoſe ſubtile parts being by diſtillation brought over, and united into very ſpirituous liquors, and ſo either totally, or in great meaſure freed from thoſe phlegmatick or aqueous parts, that diſpoſe bodies to congelation, could not be brought to freeze, either by the cold of the external air, to which in froſty nights we expoſed them, or by ſuch an application of ſnow and ſalt, as ſerved to freeze other bodies.

2. OF this ſort were, among acid menſtruums, aqua fortis, ſpirit of nitre, of ſalt; alſo oil of turpentine, and almoſt all, (I add the word almoſt, becauſe the eſſential oil of aniſeeds and the empyreumatical oil of common oil will loſe their fluidity in a leſs degree of cold, than that of our mildeſt froſts) I ſay almoſt all the chymical oils we had by us, as likewiſe ſpirit of wine, and other ſtrong ſpirits of fermented liquors, and even ſack itſelf, if it were good, would very hardly be brought to afford us any ice at all: but among the many liquors, that would not freeze, there were a few, whoſe trials afforded us ſome circumſtances not altogether unworthy their being mentioned.

As 1. I being deſirous to ſatisfy ſome friends, that it was the briſk ſpirit of the grapes, whether reſulting from, or extricated and exalted by fermentation, that kept (all) the reſt of the ſack from freezing; I took a parcel of that liquor, that would afford us no ice at all, and by the help of a lighted candle, or ſome other actually flaming body, kindled it; and letting the inflammable part burn away, the remaining part of the liquor (which was by vaſt odds the greateſt part) was eaſily brought to freeze.

NEXT, when the formerly mentioned trial was made with water and pot-aſhes, we likewiſe, in another glaſs, expoſed a ſolution, wherein the proportion of ſalt of pot-aſhes, in reference to the water, was four times greater; there being in this ʒii. of the ſalt to ℥j. only of water: and this ſolution, though the glaſs were covered with hoar froſt and ice on the outſide, froze not at all within. And likewiſe, when another time we made a very ſtrong ſolution of ſalt of tartar, that was very pure and fiery, it did not freeze, though a conſiderably ſtrong ſolution of ſalt of pot-aſhes, that was expoſed with it, did. So that theſe experiments about the glaciation of lixiviate liquors muſt be repeated, to be reduced to a certainty.

3. THAT the common expreſſed oils of vegetables will, after their manner, freeze, that is, loſe their fluidity, and become, as it were, curdled in very cold weather, is a matter of common obſervation; but I had a mind to try, whether or no train oil, that is made of the fat of animals, (commonly that of whales) though not by diſtillation, properly ſo called, yet by the help of fire, would not be more capable of reſiſting the violence of the cold; and accordingly I found, that train-oil, expoſed to the air in a convenient phial, continued fluid, notwithſtanding a more than ordinary ſharpneſs of weather: and this I tried two or three ſeveral times, but at length one

night proved ſo very cold, that the next morning I found the oil unfluid. Which differing events ſeem a little to countenance, but more to diſfavour the report of *Olaus Magnus*, who writes, that whereas in northern regions it is uſual for ſtrong places to loſe in winter the protection afforded them in ſummer, by their ditches, though never ſo wide and deep, becauſe the froſt makes them eaſily paſſable to the enemy; this inconveniency is wont to be prevented by pouring into the ditches, the ice, if there be need, being firſt broken, great ſtore of this train oil, which ſwimming upon the ſurface of the water, and being incongealable by the cold, protects the ſubjacent water from the freezing violence of the cold, and keeps the moats unpaſſable. But becauſe our author mentions this as a known and vulgar practice in thoſe icy regions, it may perhaps deſerve a little enquiry, whether the whale oil, uſed by the Swedes, Laplanders, Muſcovites, and other inhabitants of thoſe parts, be not differing, either as to the fiſhes it is made of, or as to the way of making it, or as to the way of keeping it, from ſuch train oil as we employed; unleſs perhaps it do already appear by the relation of writers belonging to thoſe countries, or of travellers, that have been in them, that *Olaus Magnus* has in that particular, as I fear he has in ſome others, miſinformed his readers.

Olaus Magnus in Hiſtoria Gentium Septentrionalium, lib. 11. cap. 20, & 21.

4. We took notice, that a ſtrong ſolution of common ſugar was eaſily enough turned into ice; but on a ſtrong ſolution of ſugar of lead we could not with ſalt and ſnow work the like change, and this, though the trial were not negligently made: which I therefore think not unworthy to be mentioned, becauſe that the two only ingredients of this ſugar were lead, which is eſteemed a very cold body, and ſpirit of vinegar, from which, as I noted above, we did, by the like degree of cold to that we here employed, obtain ice. And though in this metalline ſugar, we may well ſuppoſe the ſaline parts of the ſpirit of vinegar to be much more concentrated or united, than they were in the ſpirit; yet the ſolution muſt abound with aqueous parts: and this ſugar ſeeming but a kind of vitriol of lead, it is worth our notice, that its ſolution would not freeze, as well as that of common vitriol, though in this latter concrete, metal be corroded by a ſpirit, which, as far as can be judged by the liquors afforded in diſtillation, is very much ſharper and ſtronger than ſpirit of vinegar.

5. We likewiſe tried to freeze quickſilver, and for that purpoſe provided a bubble, that being blown with a lamp, was but thin, and ſo flat, that the ſides almoſt touched, and it held but a little mercury; and that by the figure of the glaſs, being reduced to a large ſurface, with but very little depth or thickneſs, it was far more expoſed, than if it had been in an ordinary round bubble, to the action of the cold. But we could not at all freeze this extravagant liquor, though we tried it more than once, and though the laſt time we expoſed it in the ſame veſſel to the ſame degree of cold, wherewith we made one of the following experiments, that required a very intenſe degree of that quality. And in another thin glaſs-bubble we long expoſed quickſilver to an extraordinary ſharp air: but though the cold had ſome operation upon it, not here neceſſary to be mentioned, yet we could not find, that it did at all bring it to freeze. Wherefore I could wiſh that trial were made in *Muſcovy*, *Greenland*, *Charles-Iſland*, or ſome other of the moſt icy regions, where the effects of cold (which are here upon quickſilver but languid) are the moſt conſiderable, and ſometimes ſtupendous.

6. It is very remarkable, that though not only the ſolutions of other groſs ſalt, but, as we have ſeen, divers more ſaline and ſpirituous liquors, were brought by ſnow and ſalt to congelation; yet a brine made very ſtrong of common ſalt, could not be brought to freeze at all, though we kept it expoſed with the other ſaline ſolutions,

that did freeze, during a whole night, that was exceeding ſharp. Which experiment I alſo tried many years ſince, to draw thence an argument in favour of the Carteſian hypotheſis about cold, which I ſhall not now conſider; but rather add, that being deſirous to try, with what proportions of ſea-ſalt and water the congelation of them might be effected, I found, I could freeze ſome ſea-water, that had been brought up in a barrel to that monarch of the virtuoſi, the King, for the making of trials with it; and that having in a ſingle phial expoſed to the air, in a very bitter night, a ſolution conſiſting of twenty parts of water, and one of ſalt, which is double the proportion of ſalt to be commonly found in our ſea-water, the next day we found a good part of the liquor frozen, the ice ſwimming at the top in figures almoſt like broom, ſpreading from the ſurface of the water downwards. And to add that upon the by, we ſuffered the ice of ſalt water to thaw, to try, whether it would yield freſh water, but it ſeemed not devoid of ſome brackiſhneſs, which, whether or no it proceeded from ſome parts of the contiguous brine, that adhered to the ice, I leave to further and exacter obſervations, ſince I am credibly informed, that in *Amſterdam* there are divers, that uſe the thawed ice of the ſea-water to brew their beer with, inſtead of common freſh water.

3. AND ſince I made that experiment, I find in the induſtrious *Bartholinus*'s newly publiſhed book, *De Nivis Uſu*, a confirmation of the probability of the report I juſt now mentioned, his words being theſe; *De glacie ex marinâ aquâ certum eſt, ſi reſolvatur, ſalſum ſaporem depoſuiſſe*; *quod etiam non ita pridem expertus eſt Cl. Jacobus Finckius Academiæ noſtræ ſenior, & phyſices profeſſor, bene meritus, in glaciei fruſtis è portu noſtro allatis.*

Cap. vi. page 42.

## TITLE IV.

*Experiments and obſervations touching the degrees of cold in ſeveral bodies.*

1. AFTER having treated of the bodies, that are the moſt capable of producing cold, and of thoſe, that are moſt diſpoſed or indiſpoſed to receive it, it would be methodical to take notice of the *Degrees of Cold*, to be met with in differing bodies. But though a work of this nature might ſomewhat conduce to the diſcovery of cold in general, yet it is ſo laborious a taſk; and, to be well performed, requires ſo much more of leiſure, and conveniency, than I am maſter of, that I muſt reſign it to thoſe, that are better furniſhed with them. Which I the freelier do, becauſe the experiments, which at this time make the principal part of our hiſtory, being chiefly of the higheſt *Degrees of Cold*, we may ſeem to have done ſomething of what more properly concerns our preſent deſign, by having made the experiments, anon to be ſubjoined within this preſent ſection or title. And yet thus much we elſewhere do toward the framing of a table of the *Degrees of Cold*, that we do on other occaſions ſet down thoſe hitherto unpractiſed ways, that we have employed, to eſtimate the greater or leſſer coldneſs of bodies, by ſeveral kinds of weather-glaſſes, differing from the common ones, and far more fit than they, for ſuch a purpoſe. For by hermetically ſealed thermoſcopes furniſhed with high rectified ſpirit of wine, we can eſtimate the differing degrees of coldneſs in liquors, of which we ſhall preſently mention an example. And by uſing ſuch weather-glaſſes, as have their air included not at the top, but at the bottom of the inſtrument, we can, within ſome reaſonable latitude, meaſure the coldneſs both of intire ſolid bodies, or minuter bodies, as ſalts, *&c.* by beating them alike, and very ſmall, and placing the inſtruments at equal depths in the powder of each of them: and beſides, that the ſhape of theſe thermoſcopes does, as we have elſewhere ſhewn, make them proper for theſe uſes, for which the vulgar

ones, where the included air is at the top of the inſtrument, are not fit; beſides this, I ſay, it is eaſy in theſe we make uſe of, to make the pipe ſo ſlender in proportion to the cavity of the phial, whereinto it is inſerted, that very much minuter differences of cold will be manifeſt in theſe, than are wont to be ſenſible in common weather-glaſſes. And beſides theſe two ſorts, we have elſewhere propoſed, and deſcribed a third and new kind of thermometer, wherein a drop of liquor being ſuſpended in a very ſlender pipe of glaſs, betwixt the outward and the inward air, makes it far more fit for thoſe experiments, wherein we either deſpair, or care not to meaſure the difference of cold betwixt two bodies, but are only deſirous to try, whether or no they differ in coldneſs; and in caſe they do, which of them has moſt: for theſe weather-glaſſes are ſo exceeding ſenſible even of the minute difference of heat and cold, as manifeſtly to diſcover diſparities, which other thermoſcopes are not nice enough to give us any notice of. Only this advertiſement we muſt add about them, that when we uſe them to examine the coldneſs, not of liquid, but of conſiſtent bodies, we alter a little the figure of the wide end of the glaſs; and inſtead of making it a round bubble, as we have elſewhere deſcribed, we make it with a flat or flattiſh bottom, that the whole inſtrument might thereon, as on a baſis, ſtand of it ſelf upright, and ſo, being ſtill taken up by the open and ſlender end, for fear of rarifying the included air, (which caution is here given once for all) may be transferred with a pendulous drop in the pipe, and placed ſometimes on one, and ſometimes on another of the ſolid bodies to be examined by it. For if the body, it is moved to, be more or leſs cold than that it reſted on before, that coldneſs communicated through the glaſs to the air, by which the pendulous drop is ſupported, that air's expanſion or contraction will manifeſtly appear by the riſing or the falling of the drop. And thus we have taken pleaſure to remove it from one kind of wood to another, from woods to metals, and from metals to ſtones, *&c.* But the expedients, that may be propoſed to improve theſe little inſtruments to the purpoſes we have been treating of, and the cautions, that may be added to prevent men's drawing miſtaken inferences from the informations they ſeem to give them, will take up more time, than we are willing to ſpend upon an occaſion, that will not perhaps be thought to deſerve it, nor much to require any others, than thoſe we ſhall by and by ſubjoin. And therefore I ſhall proceed to the experiment promiſed at the beginning of this title or ſection.

See preliminary diſcourſes.

2. To make ſo much as a tolerable eſtimate of the difference betwixt ſuch great degrees, as are not any of them too weak to congeal water, is a thing, which as we have not yet known to be attempted, ſo it ſeemed not eaſy to be performed. For freezing having been commonly reputed the ultimate effect or production of cold, men have not been ſollicitous to look beyond it. And though the diſparity we find betwixt ſeveral fits of weather, all of them froſty, ſeem to be too manifeſt and frequent to be probably aſcribed to nothing, but the differing diſpoſitions of our bodies; yet how to eſtimate that difference, it is not ſo obvious. For though we ſhould have recourſe to common weather-glaſſes, yet they might eaſily deceive us, ſince not only by eſtimating by them, the coldeſt day of one winter with the coldeſt day of another, but in judging of the coldneſs of any two days in the ſame fit of froſty weather, there intervenes time enough to make it doubtful, whether the varied gravitation of the atmoſphere produce not the change obſerved in the weather-glaſs. Beſides that, admitting vulgar thermometers could not, as they eaſily may, miſ-inform us, they are employed only to give us an account of thoſe degrees of cold, which nature, of her own accord, produces in the air; but not to diſcover, whether or no nature, aſſiſted by art, may not produce greater: and, it will eaſily be granted, that they are yet leſs made uſe of to help us to an eſtimate of this diſparity. And though ſome gueſs may

be made by the operations of cold upon liquors expoſed to it, yet ſome, as water, and very aqueous liquors, will freeze too ſoon, and others, as vinous ſpirits, will not at all, (that we have found) here in *England*. And though French wine will ſometimes be brought to begin to freeze, yet that happens but very ſeldom, and in many winters not at all, and leaves too great an interval betwixt the degrees neceſſary to congeal wine, and ſufficient to congeal water; not to mention the uncertainty proceeding from the differing ſtrengths of the wines.

3. UPON theſe and other conſiderations, we thought it requiſite to make uſe of an expedient, whoſe nature and uſe will be eaſily gathered out of the following experiments: and though by a miſchance, that broke my weather-glaſs, I have been hindered from meaſuring exactly in what proportion to the whole bulk the ſpirit of wine was contracted, by the ſurpluſage of cold, that was more than neceſſary to make water freeze, yet I doubt not but ſomething of uſe to our preſent theme, may be thence collected, and eſpecially the main thing deſigned will manifeſtly appear, which is the intenſity of cold produced by art, beyond that, which nature needs to employ upon the glaciating of water.

[4. A SMALL ſealed weather-glaſs furniſhed with ſpirit of wine, the ball being about the bigneſs of a ſmall nutmeg, and the cylindrical ſtem being very ſlender, and about ten inches long, the ball and part of the ſtem being immerſed in a veſſel of water, half buried in ſnow and ſalt, when the water began to freeze at top, the bottom and the ſides, (but before the ice had reached the ball, for fear it ſhould break it) the tincted liquor was found ſubſided to $5\frac{2}{3}$ diviſions, being half inches; and being taken out thence, and ice and ſalt being immediately applied to the ball, the liquor fell lower to about $1\frac{1}{2}$ diviſion.]

AND that it may not be doubted, but that the water, though in part congealed, remained warm in compariſon of the ſpirit of wine, though uncongealed, that had been refrigerated by the ſnow and ſalt, we will add this other experiment, which we find in another of our notes thus ſet down.

4 Jan. 15. [5. THE ſealed weather-glaſs being kept in the water till it began to freeze, deſcended to 5': being immediately removed into the ſame ſnow and ſalt, that made the water begin to freeze, it deſcended at the beginning very faſt, and afterwards more ſlowly, till it came to the very bottom of the ſtem, where it expands it ſelf into the ball; then being removed into the ſame glaſs of water, whence it was taken, and which was well ſtored with looſe pieces of ice, it did nevertheleſs haſtily aſcend at the beginning, and was ſoon after impelled to the former height of five diviſions and an half, or thereabouts.]

6. BUT perhaps ſome amends may be made for the diſaſter of the weather-glaſs, by adding, that I found by another trial, that the condenſation of liquors by ſuch colds, as we are wont to have, or can eaſily produce here, is nothing near ſo great as one would imagine. And though for want of a glaſs-ball, furniſhed with a neck ſlender enough, I could not make the experiment ſo much to my ſatisfaction, as perhaps elſe I might have done; yet the goodneſs of the ſcales I have made uſe of, and ſome greater care, than poſſibly every experimenter would have employed, may make the following obſervation luciferous.

7. WE took then (on a cold, but not froſty day) oil of turpentine, as a liquor, whoſe being free from phlegm or water we could eaſily be more certain of, than if we had employed ſpirit of wine; and this oil itſelf we rectified in a gentle heat, to make it the more pure and ſubtile. Then we took a ſmall round veſſel of clear glaſs furniſhed with a conveniently long ſtem or pipe, and having firſt weighed the glaſs alone in a pair of very good ſcales, we found it to weigh ℥i. ʒi. $56\frac{1}{2}$ gr. Then putting

in oil of turpentine, till it filled the round part of the glaſs, and aſcended a little way into the ſtem, we carefully marked with a diamond on the outſide of the glaſs, how high it reached, and then weighed the glaſs and the oil together, which weighed ℥ij. ʒvij. and 34½ gr. Then we put in, by degrees, a quarter of a drachm, and with a diamond carefully marked how high it reached in the pipe, and ſo we continued putting in ſeveral quantities of oil, ſtill carefully weighing each parcel in the ſcale, and marking its height on the outſide of the glaſs (which we did in order to a certain deſign, and found it a work tedious and troubleſome enough) till the liquor and the glaſs together weighed ℥iij. ʒi. 4½ grains. Then we put fair water into an open-mouthed glaſs, in which we alſo placed the little bolt-head with oil of turpentine, and by ſuch a circumpoſition of ſalt and ſnow, as is * hereafter to be often mentioned, we made the water, which was contained in the wide-mouthed glaſſes, and by which the ſpherical part of the bolt-head, containing the oil, was ſurrounded, we made this water, I ſay, begin to freeze; and when we perceived a little ice to be produced in it, we carefully marked with a diamond, to what part of the ſtem the oil of turpentine was ſubſided, and then transferring the bolt-head into a mixture of ſnow and ſalt, where we kept it for an hour or two, till we could perceive it to fall no lower, and marking with a diamond, this ſtation alſo of the liquor, we afterwards removed the glaſs into a warmer air, till the oil, by expanding it ſelf, had regained the higheſt mark, whence it had begun to ſink. Then into a very little glaſs, carefully counterpoiſed in a pair of exacter ſcales than the former, we gently poured out of the oil, till what remained reſted againſt that mark on the outſide of the ſtem, to which it fell, when the water began to freeze: and this we found to amount to ſomewhat above 9½ grains; ſo that, for conveniency of reckoning, we may ſafely enough take the intire number of 10 grains. After this, we poured out of the remaining oil into the ſame little glaſs, till what reſted in the pipe was even with that mark, to which the ſnow and ſalt had made it fall; and this parcel of oil happened to be almoſt preciſely of the ſame weight with the other: ſo that in this trial (for perhaps in others, which it were therefore worth while to make, the degree of cold may much vary the events) the artificial way of freezing we employed, made the oil ſubſide as much after it had been refrigerated and condenſed by a cold capable of freezing water, as that degree of cold had been able to condenſe it at firſt. And laſtly, having deducted the weight of the glaſs from the weight of the whole oil and glaſs, to obtain the weight of the oil alone; and having divided the weight of the whole oil, firſt, by that of the former parcel, we have mentioned to be ten grains, and then by the ſuperadded weight of the ſecond parcel, we took out, (both which parcels together we eſtimated at twenty grains) we found that rectified oil of turpentine of a moderate temper, being expoſed to ſuch a degree of cold, as would freeze common water, did, by ſhrinking, loſe but about a ninety-fourth part of its bulk; and being reduced to as great a degree of cold as we could bring it to by ſnow and ſalt, even then it loſt but about a forty-ſeventh part of its bulk: I ſay about, becauſe I thought it needleſs, as well as tedious, to mind fractions and little odd numbers; eſpecially ſince, as we formerly intimated, it was ſcarce poſſible to arrive at a great exactneſs in ſuch a neck as that of our bolt-head, though it were proportionable enough to the ball, and choſen among ſeveral, that were purpoſely procured for the trying of experiments.

* See the latter part of the next title.

8. There are ſome other trials about the degrees of cold, which for want of ice and other accommodations we could not make, as we would have done often; nor ſhall ſcarce be able to do it, till more friendly circumſtances afford us an opportunity: and yet becauſe our trials, though not proſecuted as far as we thought,

may poſſibly prove not unwelcome, we will ſubjoin ſomething about two of the chiefeſt of them.

9. THE one was deſigned to meaſure in what proportion, water of a moderate degree of coldneſs, would be made to ſhrink by the circumpoſition of ſnow and ſalt, before it begin by congelation to expand itſelf: of this, what we ſhall here take notice, is only, that by a trial purpoſely made with common water, in a round glaſs furniſhed with a long ſtem, we found the water in that ſtem to ſubſide ſo very little, that, whether or no it were inſenſible, it was inconſiderable. But probably a greater quantity of water, and a ſlenderer ſtem, would have made the ſhrinking of the liquor more notable, and upon that account it is, that I here mention it.

10. THE other thing was, to meaſure by the differing weight and denſity of the ſame portion of water, what change was produced in it, betwixt the hotteſt time of ſummer, and firſt a glaciating degree of cold, and then the higheſt we could produce by art. And in order to this, we weighed with a pair of exact ſcales, a glaſs bubble heavier than water, in that liquor when it ſeemed to be at a moderate temper, as to coldneſs, and by the diminution, which we found of the glaſs's weight in the water, we eaſily collected, according to the rules of the hydroſtaticks, the weight of as much water, as is equal in bulk to the glaſs bubble, and thereby the proportion betwixt the glaſs and an equal bulk of ſuch water, as we firſt weighed it in: then by the application of ſnow and ſalt, we made that water begin to freeze, and weighing in it again the ſame bubble, it was eaſy to collect, by the decrement of its weight in this refrigerated water, what proportion an equal bulk of the liquor did then bear to the glaſs: and by comparing theſe two differing proportions together, we were aſſiſted to make an eſtimate, how much the water was made more heavy and denſe by the action of a freezing degree of cold. Afterwards taking our time in ſummer, we thought fit in the ſame parcel of water (that had been purpoſely reſerved in a glaſs) to weigh the ſame bubble, that by the difference of its weight in the water, when made much lighter by the heat of the ambient air, we might obtain the information we deſired. To which we ſhall add, that we alſo recommended, to ſome Virtuoſi, that were likely to have the opportunity of gratifying us, that ſuch an experiment might be procured to be made in the midſt of ſummer in ſome part of *Italy*, by the help of the there not unfrequent conveniency of a conſervatory of ſnow, wherein the water might be reduced to freeze before the end of the ſame hour, at whoſe beginning the there warmer air had given it its greateſt expanſion, and ſo the difference betwixt the denſity of the ſame parcel of water might be the more conſpicuous. But as I have not received any account of my deſires from abroad, ſo coming now at home to review the memorial, I cauſed to be written of the newly mentioned obſervation, I find, that through the negligence or miſtake of an *Amanuenſis*, there muſt needs be a manifeſt overſight committed in the ſetting down the numbers which my memory does not now enable me to repair. And the ſeaſon being now improper to repeat the experiment, as well as the numerical parcel of water I had kept, and I employed both times, being thrown away, I think it may be ſufficient, if not too much, to have thus particularly intimated the way we took, without adding the cautions, wherewith we proceeded, nor what trials we made to the ſame purpoſe with high rectified ſpirit of wine, ſince unlucky accidents fruſtrated our attempts.

11. WHETHER the making of theſe kind of trials, with the waters of the particular rivers or ſeas, men are to ſail on, may afford any uſeful eſtimate, if, and how much, ſhips and other veſſels, may on thoſe waters be ſafely loaden more in winter than in ſummer, may be an inquiry, of which I ſhall not in this place take any further notice, than to intimate thus much, that the difference betwixt water highly refrigerated, and

that which is but of an uſual degree of coldneſs, is not ſo great, as ſome learned moderns ſeem to have thought. For on a day, which (though made cold by ſnow intermingled with the rain that then fell) was not a froſt, we took common water, and weighed in it a glaſs bubble, whoſe weight in the air was 150 grains, and this bubble, weighed in that water, loſt ſo much of its former weight, as to weigh about 28$\frac{5}{8}$ grains: and then by ſnow and ſalt, reducing that water to ſuch a degree of coldneſs, that it began to be turned into ice about the inſide of a ſmall open glaſs that contained it, we found the ſame bubble not to weigh at all above one eighth part of a grain leſs than it did before. So that if we may judge of the ſhrinking and condenſation of the water by the increment of weight, it ſhrunk but about a 230th part of its former bulk, and this according to a pair of ſcales, that would turn with about the 32d part of a grain: which may keep us from wondering at what we lately delivered concerning the very inconſiderable ſubſidence of the water, we expoſed to ſnow and ſalt in a ſmall bolt-head. And it may alſo make that the more probable, which we not long ſince related about the oil of turpentine's not loſing much above a 100dth part of its bulk, by being expoſed to ſuch a degree of cold, as made water begin to freeze. Whether we may from this, and from the formerly recited experiment, of the great ſubſidence of ſpirit of wine in a ſealed weather-glaſs, ſafely conclude, theſe ſubtile diſtilled liquors to be much more ſenſible than waters of cold, as well as of heat, further trials will beſt reſolve: and theſe I have not now ſo much opportunity, as I could wiſh, to purſue.

12. But they that have a mind to proſecute experiments of this kind, and others, that relate to the degrees of cold, may perchance be ſomewhat aſſiſted even by theſe relations, and eſpecially by thoſe paſſages, that mention the uſe of the ſealed weather-glaſs, furniſhed with ſpirit of wine, and of thoſe wherein a drop of liquor is kept pendulous. For the former of theſe being not ſubject to the alterations of the atmoſphere's gravitation, (nor, as may be probably ſuppoſed, by reaſon of the ſtrength of the high rectified ſpirit of wine) to be frozen, by ſending the ſame weather-glaſs (which may be portable enough, as I have tried by tranſporting one of them in a caſe, that might be eaſily carried even in a pocket) from one country to another, one may make far better diſcoveries of the differing degrees of coldneſs in differing regions, and know (ſomewhat near) how much the air even of *Muſcovy*, or *Norway*, or *Greenland* itſelf, is colder than that of *England*, or any other country, whence the weather-glaſs ſhall be ſent: the inſtrument being accompanied with a memorial of the degree, it ſtood at, when expoſed to ſuch a cold, as made water begin to freeze.

13. The other thermometer, where a drop of liquor is kept pendulous, may not only be employed in ſuch caſes, where the pipe and bubble can be erected upon the horizon, but by reaſon, that the outward air will indifferently impel the bubble laterally or upwards, upon the refrigeration of the inward, and that the bubble will not barely by its weight drop out of the inverted inſtrument, becauſe of the reſiſtance of the ſubjacent outward air; for theſe cauſes, I ſay, ſuch a thermoſcope may, as we have tried, be alſo uſed, where the pipe ſhall be held horizontal, or inclined, or even perpendicularly downwards, ſo that the flat part of the bubble may be applied to diſcover the coldneſs either of the wall, or of the ceiling of a room, or other bodies however ſituated. And if the pipe be made long and even, (as ſometimes we employ one above a foot long) not only ſenſible, but great effects of very little diſparities in the coldneſs of bodies, to which the inſtrument is applied, may with pleaſure be obſerved. And the ſame drop of liquor may be long enough preſerved uſeful in the pipe. But this advertiſement I ſhall give, that as ſenſible as this inſtrument appears

to be of the nicer differences of coldneſs, as of heat, yet they, that ſhall have the curioſity to examine with it, as I have done, the temperature, I ſay not, of more reſembling bodies, but of liquors, that may be thought to have their parts ſo differingly agitated, as common water, high rectified ſpirit of wine, and even rectified oil of turpentine, (I add not dephlegmed oil of vitriol, becauſe of ſome odd phænomena not here to be inſiſted on) will perhaps find the event ſo little, in many caſes, anſwer the expectation he would have had of uniformly finding great diſparities in their actual coldneſs, if he had not met with this advertiſement, that he will not much wonder, that a perſon, who wants not other employments for his time, was willing to decline ſo tedious and nice a taſk.

## TITLE V.

### *Experiments touching the tendency of cold upwards or downwards.*

1. THOUGH, after the conſideration of the ſphere of activity of cold, it would be the moſt proper place to take ſome notice of the direction of its activity, yet, becauſe one of the experiments, that belong to this head, is of great uſe to facilitate the trial of many of thoſe, that follow, throughout this whole collection; we will no longer delay to ſay ſomething of this matter, namely, in what line, or, if you pleaſe, towards what part the frigefactive virtue of cold bodies does operate the furtheſt and the moſt ſtrongly.

2. IT is a known doctrine among philoſophers, that the diffuſion of heat tends chiefly upwards, as the flame of a candle will burn many things held over it at a greater diſtance, than it would conſiderably warm them at, in caſe they were held beneath its level, or even by its ſides: and it is true, that in all caſes vulgarly taken notice of, the obſervation, for reaſons elſewhere diſcourſed of, holds well enough; and therefore it may be worth enquiry, whether in cold, which is generally looked upon as the contrary quality to heat, the diffuſion (from cold bodies) be made more ſtrongly downwards, than either upwards or towards the ſides.

ABOUT this matter, I can as yet find among my notes but the two following experiments, and thoſe not both together.

[A VERY thin bubble was blown at a lamp, and purpoſely made flat at the bottom, that it might be the more expoſed to the cold, and it was ſuſpended by a ſtring within a pretty deal leſs than an inch of a mixture of beaten ice and ſalt, wherewith we had half filled a conveniently large wide-mouthed glaſs; but we could not find, that a cold, capable of freezing, did ſtrike ſo high upwards, for the water in the bubble remained altogether unfrozen; which agrees very well with what we have obſerved, that a mixture of ice and ſalt did not congeal the vapours, that wandered through the air, above half a barley-corn's breadth higher, than the mixture in the glaſs reached.]

3. [A MIXTURE of ſnow and ſalt being put into a phial with a long neck, the round part of it was by a weight kept under water, out of which being taken after a while, the outſide of the glaſs beneath the ſurface of the water was caſed with ſolid ice, *N. B.* eſpecially about the bottom of the phial, of greater hardneſs and thickneſs than any one could eaſily imagine.]

4. THUS far the notes, from which nevertheleſs I will not poſitively conclude, though they ſeem to perſuade it, that the tendency of the cold produced by bodies qualified to freeze others is greater downwards than upwards: for the ſatisfactory determination of that matter may, for aught I know, require trials more artificial and

nice, than thoſe we have been reciting. And I could wiſh, that I could find the laſt of them to have been carefully repeated and regiſtered, becauſe it ſeems ſomewhat ſtrange, that the ice ſhould be much thicker at the bottom of the phial, than elſewhere; in regard that when we have, as we very frequently have, put mixtures of ſnow and ſalt into phials, and left them in the open air, we generally obſerved, that the outſide of the glaſs was caſed with ice, or covered with hoar froſt, directly over againſt that part of the inſide of the glaſs, wherein the frigorifick mixture was. So that part of the ſnow and ſalt reſolving one another, and falling down in the form of a liquor to the bottom, the unmelted part of the mixture would float upon this liquor, and the external ice would appear over-againſt the floating mixture, by which it was generated: ſo that as the mixture grew thinner and thinner, ſo would the zone or girdle, if I may ſo call it, of external ice, grow narrower and narrower, till at length, when the ſnow was quite melted away, the external ice would quickly alſo vaniſh. But from this obſervation (which we frequently made) that as in ſuch phials the ice did not appear (as I juſt now related) above half a corn's breadth higher than the mixture, in the glaſs; ſo I remember not to have obſerved it much lower beneath the mixture: from thoſe things, I ſay, it may be probably conjectured, that even the coldeſt bodies (at leaſt unleſs their bulk alter the caſe) do not diffuſe their freezing virtue, either upwards or downwards to any conſiderable diſtance.

5. THESE trials, as I was intimating, may ſuggeſt ſome difficulties about the laſt of the two experiments, tranſcribed out of my notes. But as it is evident theſe obſervations were made in the open air, by the freezing of its roving vapours, and the mentioned experiment was made under water; ſo how much this difference of mediums may alter the caſe, as to the way of the diffuſion of cold, I dare not, till further trial, boldly determine: eſpecially ſince one circumſtance, to be under the next title mentioned, about the freezing of eggs, may paſs for an additional experiment as to our preſent inquiry. For the caſes obtained by frozen eggs ſuſpended under water ſeem to argue, that the diffuſion of their cold was made every way, ſince they were quite incloſed in the ice, they had produced.

6. THOUGH the experiment of freezing water, by the intervention of ſalt and ſnow, be not a new one for ſubſtance, yet I hold it not amiſs, to make a further mention of it on this occaſion. Becauſe that what I am to deliver about it, is a particular not taken notice of (that I know of) by others: the premiſing of which will, according to what we lately intimated, much facilitate the trial of many of the experiments to be ſet down in the following part of theſe papers, and will indeed appear to be of no ſmall moment in our whole attempt of framing an *Hiſtory of Cold*. For it has long ſeemed to me one of the chief things, that has hindered men from making any conſiderable progreſs in this matter, that whereas glaſs-veſſels are generally much the moſt proper to freeze liquors in, becauſe their tranſparency allows us to ſee, what changes the cold makes in the liquors expoſed to it; the way of freezing with ſalt and ſnow, as it has been hitherto uſed, does almoſt as little, as the common way of barely expoſing veſſels to the cold air in froſty weather, prevent the unſeaſonable breaking of the glaſſes. For in both theſe ways, the water or other liquor uſually beginning to freeze at the top, and it being the nature of glaciation, as we ſhall ſee anon, to diſtend the water and aqueous liquors it hardens, it is uſually and naturally conſequent, that when the upper-cruſt of ice is grown thick, and by reaſon of the expanſion of the frozen liquor bears hard with its edges againſt the ſides of the glaſs contiguous to it, the included liquor, (that is by degrees ſucceſſively turned into ice) requiring more room than before, and forcibly endeavouring to expand it ſelf every

way, find it leſs difficult to burſt the glaſs, than lift up the ice; and conſequently does the former, and thereby ſpoils the experiment, before it be come to perfection, or have let us ſee what nature would have done, if ſhe had not been thus hindered in her work.

7. THE conſideration of this invited me to alter the common way of freezing, and order the matter ſo, that whenſoever I pleaſed, the expoſed liquor ſhould not begin to freeze at the top or ſides, but at the bottom; which I concluded it very eaſy to do, by mingling the ſalt with that part only of the ſnow, which was to lie beneath and about the bottom of the glaſs I placed in it. For by this means the ſnow, that was contiguous to the ſides, was able but to cool the water, and diſpoſe it to glaciation; whereas the mingled ſnow and ſalt, on which the bottom of the glaſs reſted, did actually turn the neighbouring liquor into ice, and lift up the incumbent liquor towards the higher and empty parts of the glaſs. And this liquor alſo I could afterwards freeze at pleaſure, without danger of breaking the veſſel, only by ſo applying ſalt and ſnow to the ſides of the glaſs, that they never reached, except perhaps at the very concluſion of the experiment, ſo high by a reaſonable diſtance, as the upper ſurface of the liquor in the glaſs; ſo that the ſuperiour parts of that liquor were always kept fluid, and capable of being eaſily impelled higher and higher, by the expanſion of the freezing parts of the ſubjacent liquor.

8. THE ſpeculative inference, that may be drawn from this experiment, of making water begin to freeze at the bottom, not the top, will be more properly taken notice of in another place: in the mean time, I ſhall only intimate by the way, that there is no great neceſſity of any nice proportion of ſalt to ſnow, nor of any exquiſite mixture of them: a third or fourth part, or thereabouts, of ſea-ſalt, in reference to the ſnow, will not do amiſs; nor do I uſually put ſalt to all the ſnow at once, unleſs in ſome caſe, wherein I have a mind to freeze a liquor quickly, and make a ſpeedy reſolution of the ſnow and ſalt in order thereunto. To which I ſhall only add, that by the way abovementioned, I do upon particular occaſions make the expoſed liquor freeze, not at the bottom or the top, but next to what ſide of the glaſs I pleaſe, according to the exigency of the experiment. But though it may ſuffice to have hinted the ſpeculative inference, that may be drawn from this way of freezing liquors, it will be expedient to give explicitly this practical advertiſement concerning it; that whereas it ſeems to have been taken for granted, that ſnow is neceſſary in this artifice, and we our ſelves were for ſome time led away with the reſt by that ſuppoſition: yet that is but a preſumption, and ought to be removed, as one very prejudicial to thoſe, that with us deſign the proſecuting experiments, in order to the *Hiſtory of Cold*. For ſnow is but ſeldom to be found on the ground in compariſon of ice, and being but a congeries of many ſmall icicles, with much air intercepted among them, it is not (*cæteris paribus*) near ſo durable, as the more intire body of ſolid ice. And yet we have found by frequent experience, that ice, well beaten in a mortar, will ſerve our turn for artificial glaciations, as well (if not in ſome reſpects better) as ſnow; and therefore in this *Hiſtory of Cold* we indifferently preſcribe ſnow and ſalt, or ſalt and ice, as the ingredients of our glaciating mixtures.

In the diſcourſe touching the primum frigidum.

## TITLE VI.

### *Experiments and obſervations touching the preſervation and deſtruction of (eggs, apples, and other) bodies by cold.*

1. IT is a tradition common enough, (though not here in *England*, yet among thoſe, that have given us accounts of very cold countries) that if eggs or apples, being

frozen, be thawed near the fire, they will be thereby ſpoiled; but if they be immerſed in cold water, the internal cold will be drawn out, as they ſuppoſe, by the external, and the frozen bodies will be harmleſly, though not ſo quickly thawed. This tradition I thought fit to examine, not only becauſe it may be doubted, whether it will ſucceed in our more temperate climate, and becauſe I love not to rely upon traditions, when I have the opportunity to examine them (eſpecially if no one credible author affirms them upon his particular knowledge) but alſo becauſe I thought the experiment, if true, might be ſo varied and made uſe of, as to become luciferous enough, and afford us divers phænomena of cold, not ſo eaſy to be produced by the more known ways of experimenting. And accordingly having expoſed ſome of theſe bodies to a cold, that was judged ſharp enough, we afterwards put them in water, but found not the event anſwer our expectations, no ice appearing to be generated: nevertheleſs we were not hereby ſo diſcouraged, as not to repeat the experiment (which we judged to be not unlikely) with more ſollicitouſneſs and advantage than before; and having thereby brought it to ſucceed, we afterwards made ſeveral trials of it with ſeveral diſtinct aims, but cannot now find any entry of divers of them. But thoſe I have hitherto met with among my notes, I ſhall ſubjoin, as having in them ſome particulars, that may afford uſeful hints to an inquirer into the hiſtory and nature of cold. And I ſhall ſet down together, and that in this place (though it would not otherwiſe be the moſt proper) thoſe I have met with, becauſe ſome circumſtances of one or other of them may be of uſe to us on ſeveral occaſions in the preſent treatiſe.

2. [An egg weighing twelve drachms and one grain wrapt in a waxed paper (to keep it from the liquor of the thawing ſnow) and frozen with ſnow and ſalt, wanted four grains of that weight: put into a diſh of fair water, there cruſted as much ice about the outſide, as made the egg and ice fifteen drachms and nine grains. The ice being taken off from the ſhell, and the ſhell very well dried, the egg was found to weigh twelve drachms and twelve grains; the egg being broken, was found almoſt quite thawed; the egg frozen ſwam in water; being thawed, it ſunk.]

3. [We took two eggs ſtrongly frozen, and in a room, where there was a good fire, we put one of them into a deep wooden diſh full of very cold water, and ſet the other by it, upon a table about two yards from the fire, that they might be in air, of the ſame temper as to heat and cold; then perceiving the egg, that lay under water, to have obtained a thick cruſt of ice, we took it out; and having firſt freed it from the ice, broke it, and found, that ſome part of the white was not yet freed from a pretty ſtore of little parcels of ice, but the reſt of the white (which was much the greater part) and the yolk ſeemed to be much-what of the ſame conſiſtence, as if the egg had not formerly been frozen; whereas the other egg, that lay by upon the dry table, had not only its whole white frozen into a conſiſtent body, but the yolk it ſelf, though we ſaw no diſtinct particles of ice in it, was grown ſo hard, that it cut juſt like the yolk of an egg over-boiled; and being cut quite through, ſhewed us certain concentrical circles of ſomewhat differing colours, with a ſpeck much whiter than any of them in the middle of the yolk; which laſt circumſtances, whether they were accidental or no, further obſervation muſt determine.]

Note, that though we have not found above once, that frozen eggs would ſwim, yet when we had broken ſuch eggs, the frozen white would ſwim, but not the yolk.

4. We afterwards repeated the experiment of laying two frozen eggs near together in the place above mentioned, the one under water, and the other out of it, till that put in water had got a thick icy cruſt, and by breaking of them both, preſently after

one another, were confirmed in the perſuaſion, that frozen eggs will thaw by great odds (*cæteris paribus*) faſter when immerſed in water, than when ſurrounded only with air.

5. [WE likewiſe took a frozen egg, and from a fixed place ſuſpended it ſo by a ſlender packthread, that it hung quite under water, without yet touching the veſſel, that the water was in. This we did partly upon another deſign, and partly to obſerve, whether or no the ice would in this caſe be conſiderably thicker or thinner againſt the lower parts of the egg, as we formerly mentioned ourſelves to have obſerved it to be very manifeſtly at the lower parts of a glaſs, which having ice and ſalt in it, was immerſed under water; but when we took out the egg, after we ſaw, that its icy caſe had covered the packthread it was hung by, we found the caſe, upon breaking it, of a thickneſs uniform enough to keep us from concluding any thing from this trial; ſince, though there were a pretty deal of ice generated at ſo ſmall a diſtance from the caſe of the egg, that it ſeemed to owe its production to the ſame cauſe, yet, which was ſomewhat odd, we did not find, that this ice ſtuck to that, which did immediately imbrace the egg, though we had ſome faint ſuſpicion, that the rudiments of it might have been very early parted from the egg, by ſome little ſhaking of the table, occaſioned by people's paſſing to and fro in the room.]

6. [WE took ſome pippins, and expoſing them to freeze all night, and putting them the next morning into a baſon of very cold water, (though in a warm room) they were not long there without being incloſed with caſes of ice of a conſiderable thickneſs. Where note, 1. That that part of a floating apple, that was immerſed under water, had a very much thicker coat than the other part, which remained above it. 2. That the extant part ſeemed likewiſe to be harder than the immerſed. 3. That one of theſe pippins being purpoſely left out of the baſon, but laid by it, ſeemed, upon cutting, to be harder and more frozen than thoſe apples, which had been put into the water; which ſcarce ſeemed to be at all harder than ordinary pippins, that had never been ſet to freeze, at leaſt as to thoſe parts of the apples, that were near the rind, and conſequently near the ice. 4. That neither frozen pippins nor frozen eggs, notwithſtanding their great power of turning part of the contiguous water into ice, did appear to us to detain or congeal any of the roving vapours of the air, as ice or ſnow included with ſalt in glaſſes is (as we have formerly obſerved) accuſtomed very remarkably to do.]

7. [WE took eggs, and froze them with ice and ſalt, till the ſhells of them were made to crack: then we took them out, and put one of them in milk, two of them in a wide drinking-glaſs full of beer, and two more in a large glaſs, wherein we covered them with ſack, that was poured in till it reached much higher in the glaſs than the eggs. But none of theſe trials produced, as we could perceive, one grain of ice.] And being deſirous to ſee, whether the acid ſalt of vinegar, or the cold in a well-frozen egg, would have the chief operation, if thoſe two bodies were put together; I found upon trial, that the ſaline parts of the vinegar began to diſſolve the egg-ſhell, as appeared by the much altered colour of it, but the cold of the ice in the eggs was not able to freeze any part of the water or phlegm of the vinegar.

8. WE had alſo thoughts of trying, whether or no pieces of iron of ſeveral ſhapes and bigneſſes, being for divers days and nights expoſed to the freezing air, and afterwards immerſed in water, would produce any ice, as frozen eggs and apples do. For the brittleneſs of the laths of ſtone-bows in ſharp froſts, together with other obſervations elſewhere mentioned, ſeem to argue, that (to uſe a popular phraſe) the froſt

does alſo get into theſe bodies. And I have been aſſured by one, whom the trials I had made with eggs and apples, invited me to conſult, that a great cheeſe he immerſed in water in a cold country, was preſently covered over with ice. But though, as I ſaid, I had thoughts of making the above-mentioned trials, yet for want of a froſt ſufficiently durable, I was not able to effect what I deſigned. But thus much I tried, that though I kept good lumps of iron, and, as I remember, of other metals, beſides pieces of glaſs, and a ſtone or two of a convenient ſize, in ſnow or ſalt, I know not how much longer, than would have ſufficed to make eggs or apples, or ſuch kind of things, fit to produce ſtore of ice in water, upon their being thawed therein; yet we could not find, that upon the immerſing the ſeveral newly named mineral bodies, there was the leaſt ice produced in the cold water, where we kept them covered. I muſt not, neverthelеſs, omit to make ſome mention of that, which lately ſeemed to happen at the door of our own laboratory, (reſpecting the north eaſt) where ſome glaſſes, newly brought from the ſhop, and not imployed, lying in a baſket, as they poured water into one of them to rince it, part of it was preſently turned into ice, whilſt one of my domeſticks held it in his hand; who coming preſently to ſhew it me, I ſuſpected the ice might have come from, or rather with the water, that was poured into the glaſs, but upon inquiring was aſſured of the contrary.

9. But here I muſt not omit another trial relating to the former experiments, which may ſeem ſomewhat odd, if its event prove conſtantly the ſame, as when we tried it. For after theſe and divers other experiments made with frozen eggs and apples, we thought it might be worth the examining, whether or no ice and the liquors of theſe concretes would produce the like effects, as frozen eggs and apples. And becauſe it is uſually an eaſier way than that, which is more common, of bringing bodies, whoſe degree of cold is more languid, to freeze water, to include them with ice or ſnow in a ſingle phial, and ſo put them upon acting only upon the minute, and eaſily congealable vapours, that wander in the air; we took that courſe in the trials we are mentioning: whoſe ſucceſs is thus briefly ſet down in one of our notes.

[10. Ice and juice of pippins, well ſhaken together in a ſingle phial, produced abundance of dew; but we could not ſatisfy ourſelves, that it produced any ice.]

[11. Also ice and the white of an egg, moderately beaten into a liquor, were tried, with juſt the like ſucceſs; but theſe trials having ſcarce been made above once, and at moſt but twice, are to be repeated.]

12. As for what is ſaid, that eggs and apples thawed in the water are better preſerved than thawed by the fire's ſide; we tried it in pippins, (for in eggs the experiment is not ſo eaſily and quickly made) and, as far as we could diſcern, found it true, and ſomewhat wondered to ſee, how ſoon, and how much putrefaction was induced into thoſe looſely contexed bodies by an overhaſty thawing.

13. If we may believe the relations of navigators, and others of good credit, (of one or two of whom I had the opportunity to make inquiry) there may be good uſe made of what happens in the different ways of thawing eggs and apples, by applying the obſervation to other bodies, and even to men, that happen to be dangerouſly nipped by exceſſive cold. For it is a known obſervation among thoſe, that have inhabited or viſited the northern climates, that if thoſe, whoſe hands or feet, or faces happen to be frozen, approach them too near or haſtily to the fire, they are in danger of loſing, or at leaſt much prejudicing the over-haſtily thawed parts. ‘Upon divers ‘of us,’ (ſays Captain *James*, ſpeaking of his companions) ‘had the cold raiſed ‘bliſters as big as walnuts. This we imagined to come, by reaſon that they came ‘too haſtily to the fire.’ And therefore they, that are more careful to be ſafely than

quickly delivered from the painful cold, are wont, before they come near the fire, whether it be open or in ſtoves, either well to waſh their hands, or other frozen parts, in very cold water, or elſe to rub them well with ſnow it ſelf. And this brings into my mind, that I ſometimes endeavoured to find by trial, what beef long expoſed to freeze and differingly thawed would teach me, by way of confirmation of this tradition; but being then obliged to unſeaſonable removes from the place, where I made my trials, they did not for that reaſon afford me the ſatisfaction I deſired; but meeting with an intelligent perſon, that had been an houſekeeper in *Muſcovy*, and enquiring of him, whether he had obſerved any thing about this matter, he told me, that having once had two very large cheeſes frozen, he thawed one of them in water, and the other in a ſtove, but found, that thawing in water was much the better way of the two. And I was well pleaſed to be anſwered by him, that the cheeſe, thawed in water, did ſoon acquire therein a cruſt of ice.

14. BUT more memorable is that relation, which I remember I have read in the experienced chirurgeon *Fabricius Hildanus*'s treatiſe of *Gangrenes*, where he relates from credible teſtimony, how the whole body of a man was ſucceſsfully thawed, and, which is more ſtrange, caſed all over with ice, by being handled as our eggs and apples were. His own words, becauſe the narrative may prove of ſome uſe, I ſhall ſubjoin, and they are theſe: *Narravit mihi vir quidam nobilis & fide dignus, ſe, cum eas regiones peragraret, incidiſſe aliquando in viatorem ſecundùm viam frigore rigidum, ac pene mortuum, quem plauſtro ſuo impoſitum, cum deduxiſſet in diverſorium, hoſpes illico demerſit in frigidam, quo facto undequaque ita erupit gelu, ut ipſius corpus glacie, ſeu ferreo thorace contectum conſpiceretur. Tum quoque propinatum illi ajebat cyathum ampliorem hydromelitis, quo illi ſeu potu ordinario utuntur, addito pulvere cinnamomi, caryophillorum, & macis, unde ſudor in lecto provocatus eſt; atque ita ægrum ad ſe rediiſſe amiſſis duntaxat manuum & pedum extremis articulis. Hinc intelligimus hanc methodum ſanandi congelatos veram ac tutam eſſe, ac eam etiam probat ſummus philoſophus, qui regiones illas frequentavit*, &c.

Gulielmus Fabricius Hildanus de Gangr. & Sphacelo, chap. 10.

15. THE experiment delivered at the beginning of this title, (of ſpeedily producing ice on the outſide of frozen eggs and apples, by immerſing them in cold water) I take to be one of the two or three moſt illuſtrious, I have hitherto met with about congelation; and as likely as any to aſſiſt us to inveſtigate the cauſes of it. But though the phænomena ſeem very favourable to their hypotheſis, that ſuppoſe congelation to be effected by the ingreſs of frigorifick atoms into the water or other bodies to be congealed; yet (for ſome reaſons) I ſhall not here offer to draw any ſpeculative inference from the experiment, contenting my ſelf to have here, and at the beginning of this ſection, hinted *in tranſitu* the hopefulneſs of its proving luciferous.

16. BUT I remember, that the title of this ſection promiſes ſomething concerning the preſervation and deſtruction of other inanimate bodies, as well as eggs and apples, by cold; but as that intimated promiſe makes the laſt part of the title, ſo what I have to deliver on this ſubject muſt not be expected to be other than the laſt part of this ſection. And indeed to be able to add much to that little, which is generally known about this ſubject, I ſhould either have lived in colder climates than ours, or have had, which I had not, the opportunity of making experiments, that require length of time. And therefore I ſhall only propoſe a general conſideration about this matter, and ſubjoin a few of the chief obſervations I have met with in navigators or others about it. That then, which I would premiſe in general, is only this; that whether bodies be frozen by the ingreſs of frigorifick atoms, which by their intruding in ſwarms can ſcarce avoid diſcompoſing the texture of the body; or whether it be made by the receſs of ſome matter, that did, before congelation, more ſtrongly agitate its

parts; which way ſoever, I ſay, freezing is effected, it is manifeſt, that the nature of a frozen body is, at leaſt for the time, much altered; and therefore we thought fit to place it among our general articles of inquiry about cold, what the effects of it may be as to the conſervation or deſtruction of the texture of bodies. But as for the duly proſecuting this inquiry, we do, as we lately intimated, want the time and conveniency, we judge needful for ſuch a work; the matter ſeeming to require, that it be watchfully and conſiderately managed, and that both the nature of particular bodies, and the differing degrees of cold, and the differing times, wherein the condition of the expoſed body is eſtimated, be taken into conſideration. For we find, that a moderate degree of cold preſerves many bodies, and that glaciation deſtroys, or at leaſt prejudices moſt others (probably by diſcompoſing or vitiating their texture) when they come to be thawed, though whilſt the froſt is in them, it keeps almoſt all bodies from diſcloſing any putrefaction.

17. This being the general conſideration I intended to propoſe, it remains, that I add out of credible writers, or other relaters, ſome obſervations to illuſtrate and confirm the chief particulars comprehended in it.

And firſt, that a moderate degree of cold conduces much to the preſervation of the greateſt part of inanimate bodies, is a thing vulgarly taken notice of and acknowledged. And I do not readily remember any inſtances, that manifeſt, that any degree of cold, though more than moderate, provided it fall ſhort of freezing the bodies expoſed to it, does ſpoil them. *Regii Mutinenſes* (ſays the induſtrious *Bartholinus*) *nivem hoc fine arctè compactam ſervant in cellis nivariis, in quibus ſervente æſtate vidi carnes mactatorum animalium à putredine diu ſe conſervaſſe.* The next thing I ſhall mention to our preſent purpoſe, is a memorable paſſage in captain *James*'s voyage; which ſhews, that ſo great a degree of cold, as may be ſuppoſed to have reigned in his ſhip, that was frozen up all the winter in one of the coldeſt regions of the world, was not great enough to ſpoil the meat and drink, that had laid all that time under water, becauſe it ſeems by the ſtory, that they were not actually frozen; the words of his journal are theſe: "By the ninth of *May* we were come to, and got up our five "barrels of beef and pork, and had four butts of beer, and one of cyder, which "God had preſerved for us: it had lain under water all the winter; yet we could "not perceive, that it was any thing the worſe." Which is the more remarkable, becauſe of what we ſhall note by and by, both out of other books, and even out of this, about what became of a ſtronger liquor than beer, once brought to glaciation; and it ſeems our navigator found cold, if extremely intended, ſo deſtructive a thing, that he thought fit to take notice in his journal, that even a cable having lain under the ice all the winter, was not in *June* found a jot the worſe.

Barthol. de uſu nivis, p. 80.

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18. And it ſeems by a paſſage in *Simlerus*'s account of the *Alps*, that even intire bodies may be very long preſerved by ſnow, and, as far as I can gueſs by the ſtory, without glaciation. *Refert* (ſays *Bartholinus*, ſpeaking of him) *in Rhetis apud Rinwaldios, nivium è monte ruentium moles ſylvam & proceras abietes dejeciſſe; accidiſſe etiam Helvetio militiæ per Alpes iter faciente, ut* 60 *homines & plures eadem nivis conglobatione opprimerentur. Hoc igitur nivium tumulo ſepulti, ad tempus æſtatis deliteſcunt, quo ſolutâ nonnihil nive deciduâ, corpora mortua inviolata patent, ſi ab amicis, vel tranſeuntibus quærantur. Vidimus ipſi triſte hoc ſpectaculum*, &c.

Barthol. de figura nivis, pag. 79.

19. Secondly, I could alledge many inſtances to ſhew, that many, if not moſt inanimate bodies, (I ſay inanimate, becauſe of the gangrenes and ſphacelations that often rob living men of frozen toes, noſes, and ſometimes other parts) if they be actually frozen, will not diſcloſe any putrefaction, whilſt they continue in that ſtate.

Nor is this much to be wondered at, ſince whether he will ſuppoſe, that in glaciation the moiſt and fluid parts are wedged in by intruding ſwarms of frigorifick atoms, or that thoſe reſtleſs particles, that were wont to keep the body fluid or ſoft, are called forth of it, be the cauſe of glaciation; which ſoever of theſe two ways we pitch upon, we muſt in frozen bodies conceive an unwonted reſt to be produced of thoſe moveable particles, whoſe internal commotions, and diſorderly coalitions and avolations, are either the cauſes or the neceſſary concomitants of corruption.

20. ON this occaſion I remember, that meeting with a knowing man, whoſe affairs ſtopped him during the winter upon the coaſts of *Sweden* and *Denmark*, being deſirous to learn of him, how long they could in thoſe colder climates preſerve in winter dead bodies unburied, and yet uncorrupted, he told me, he had opportunity to obſerve, that though the froſt laſted, as it uſually did in that ſeaſon, three or four months together, or longer, the bodies might without any embalming, or other artificial way of preſervation, be kept untainted by the bare coldneſs of the air. Of bodies laſting long unputrified in ice, navigators and others have afforded us ſeveral inſtances; but we will mention two, becauſe they contain ſomething more remarkable than the reſt. The one is thus delivered by *Bartholinus: Notandum, corpora occiſorum hyeme eodem poſitu, eademque figurâ permanere rigidâ, quâ ante eadem deprehenſa ſunt. Viſum id extra urbem noſtram, quum* 11 Feb. 1659. *oppugnantes hoſtes repellerentur, magnaque ſtrage occumberent: alii enim rigidi iratum vultum oſtendebant, alii oculos elatos, alii ore diducto ringentes, alii brachiis extenſis gladium minari, alii alio ſitu proſtrati jacebant. Imo ex mari gelato, primo vere reſoluto, eques equo ſuo inſidens integer emerſit, neſcio quid manibus tenens.* The other inſtance is afforded us by captain *James*'s Journal, and is by him thus delivered: “In the evening (of the 18th of *May)* the maſter of our ſhip, after burial “returned aboard ſhip, and looking about her, diſcovered ſome part of our gunner “under the gun-room ports. This man we had committed to ſea at a good diſtance “from the ſhip, and in deep water, near ſix months before. The 19th in the morning I “ſent men to dig him out, he was faſt in the ice, his head downwards, and his heel “upwards, for he had but one leg; and the plaiſter was as yet at his wound: in the “afternoon they digged him clear out, after all which time he was as free from “noiſomeneſs, as when we firſt committed him to ſea. This alteration had the ice “and water and time only wrought on him, that his fleſh would ſlip up and down “upon his bones like a glove on a man's hand.” But there is one pertinent particular more, which, if it be ſtrictly true, is ſo very remarkable, that I cannot on this occaſion forbear to annex it; which is, That according to the relation of the merchants of *Copenhagen*, that returned thither from *Spitzberg*, a place in *Greenland*, the extreme cold will there ſuffer nothing to putrify and corrupt, inſomuch that buried bodies are preſerved thirty years intire and inviolated by any rottenneſs.

Barthol. de uſu nivis, p. 83.

Capt. James's travels, p. 76.

Barthol. de uſu nivis, c. 12.

21. THIRDLY, though whilſt bodies continue frozen, the cold (as may be ſuppoſed) by arreſting the inſenſible particles, from whoſe tumultuary motions, and diſorderly avolations corruption is wont to proceed, may keep the ill operations of cold upon the violated textures of bodies from appearing; yet when once that impediment is removed, divers bodies make haſte to diſcover, that their texture was diſcompoſed, if not quite vitiated by the exceſſive cold. I might alledge on this occaſion, that I have ſhewn divers ingenious men by an experiment that I have taught in another * treatiſe, that the change produced in the textures of ſome bodies by glaciation, may be made manifeſt even to the ſight. For by freezing an ox's eye, the cryſtalline humour, which in its natural ſtate is tranſparent enough, to deſerve its name of cryſtalline, though not fluid enough to deſerve the name of humour, loſt with its former texture all its diaphaneity, and being cut in two with a ſharp knife, appeared

* Of the uſefulneſs of Experimental Philoſophy.

quite throughout very white. But for confirmation of this I ſhall rather add, that I remember, that the perſon formerly mentioned, that had made trial of the two cheeſes, confeſſed to me, That, though that, which had been thawed in cold water, was very much the leſs ſpoiled, yet they were both of them manifeſtly impaired (and the other of them was ſo in its very conſiſtence) by the froſt, though the bulk of the cheeſes was very conſiderable, and though they were both of them, of a more than ordinarily good and durable ſort.

22. The next thing I ſhall alledge to this purpoſe, is the obſervation of the *Hollanders*, even by ſuch a degree of cold as they met with in *Nova Zembla*, before the middle of *October*, at which time their ſtrong beer, by being partly frozen, had its texture ſo vitiated, that the reunion of its unfrozen to its thawed parts could not reſtore any thing near ſuch a ſpirituous liquor, as it was before. "We were forced "(ſays *Gerat de Veer*, that wrote the ſtory) to melt the beer, for there was ſcarce any "unfrozen beer in the barrel, but in that thick yeaſt, that was unfrozen, lay the "ſtrength of the beer, ſo that it was too ſtrong to drink alone; and that which was "frozen taſted like water, and being melted, we mixed one with the other, and ſo "drank it, but it had neither ſtrength nor taſte." And in the next month's journal he tells us, that their beſt beer was for the moſt part wholly without ſtrength, ſo that it had no ſavour at all. But a more remarkable inſtance to our preſent purpoſe is afforded us by our countryman captain *James*, becauſe it manifeſts the cold to have the ſame effect upon a much ſtronger and more ſpirituous liquor. "I ever doubted "(ſays he in his journal) that we ſhould be weakeſt in ſpring, and therefore "had I reſerved a tun of *Alicant* wine unto this time. Of this, by putting ſeven "parts of water to one of wine, we made ſome weak beverage, which (by "reaſon that the wine by being frozen, had loſt his virtue) was little better "than water."

Purch. Lib. 3. cap. 5. ſect. 2. pag. 493.

Pag. 73.

23. And I remember, that a learned man, whom I aſked ſome queſtions concerning this matter, told me, that in a northern country, leſs cold than *Muſcovy*, he had obſerved, that beef having been very long frozen, when it came afterwards to be eaten, was almoſt inſipid; and being boiled, afforded a broth little better than common water.

24. If I had not wanted opportunity, I ſhould here ſubjoin an account of ſome trials, for which I made proviſion, as thinking them not abſolutely unworthy the making, though extravagant enough not to be likely to ſucceed. For I had a mind to try, not only whether ſome plants, and other medicinal things, whoſe ſpecifick virtues I was acquainted with, would loſe their peculiar qualities by being throughly congealed, and (ſeveral ways) thawed; and whether thawed hartſhorn, of which the quantity of ſalt and ſaline ſpirit of ſuch a determinate ſtrength ſhould beforehand be tried by diſtillation, would, after having been long congealed, yield by the ſame way of diſtillation the ſame quantity of thoſe actual ſubſtances, as if the hartſhorn had not been frozen at all. But I had alſo thoughts to try, whether the electrical faculty of amber, (both the natural, and that factitious imitation of it I elſewhere teach) and whether the attractive or directive virtue of load-ſtones, eſpecially very weak ones, would be either impaired, or any ways altered by being very long expoſed to the intenſeſt degrees of cold within my power of producing. But to have named ſuch extravagancies, is that, which I think enough, and others I fear may think too much.

25. Yet ſome few things I ſhall ſubjoin on this occaſion, becauſe it will add ſomewhat not impertinent to the deſign of this treatiſe (which is to deliver the phænomena of cold) as well as countenance what I have been propoſing; and thoſe things are, that I can by very credible teſtimony make it appear, that an intenſe cold may have a greater operation upon the texture even of ſolid and durable bodies, than we in this

temperate climate are commonly aware of. I ſhall not urge, that even here in *England* it is generally believed, that men's bones are more apt to break upon falls in froſty, than in other weather, becauſe that may poſſibly be imputed to the hardneſs of the frozen ground. Nor, that I remember, when I was wont to make uſe of ſtone-bows, I found it a common obſervation, that in froſty weather the laths, though of ſteel, would, by the cold, be made ſo brittle, that unleſs extraordinary care were had of them, or ſome expedients were uſed about them, they would be apt to break. Nor yet, that an ingenious overſeer of great buildings has informed me, that thoſe that deal in timber and other wood, find it much more eaſy to be cleft in hard froſts, than in ordinary weather. Theſe and the like inſtances I do, as I was intimating, forbear to urge, becauſe theſe effects of cold are much inferiour to thoſe that have been met with in more intemperate regions.

26. AND to begin with its operation upon what we were laſt treating of, wood. Of *Charleton*-iſland, captain *James* has this paſſage about the timber, they Page 67. employed upon their works: ‘ The boys (ſays he) with cuttle-axes muſt cut ‘ boughs for the carpenter; for every piece of timber, that he did work, muſt firſt ‘ be thawed in the fire.’ And a little before, he tells us, that even when they found ‘ a ſtanding tree, they muſt make a fire to it to thaw it, otherwiſe it could ‘ not be cut.’

27. AND I remember, that two ſeveral perſons, both of them ſcholars, and ſtrangers to one another, that had occaſion to travel as far as *Moſcow*, aſſured me, that they divers times obſerved in extreme froſts, that the timber-work (whether the boards or the beams) of ſome houſes, which, according to the cuſtom of that country, were made of wood, and perhaps, not well ſeaſoned, would, by the operation of the cold, be made to crack in divers places, with a noiſe, which was ſurprizing enough to them, eſpecially in the night.

28. I REMEMBER alſo, that a phyſician, who lived for ſome years in one of the coldeſt plantations of the *Weſt-Indies*, related to me, that he had obſerved the bricks, he had employed about building, to be very apt to be ſpoiled by the long and vehement froſts of the winters there; where he likewiſe ſaid, that it was a uſual thing for the houſes builded of brick, to decay in fewer years by far, than here in *England*; which he ſaid was generally, and, as he thought, truly imputed to the exceſſive cold, which made the bricks apt to crumble, and moulder away. But though I dare not lay much weight on this obſervation, unleſs I knew, whether the bricks were ſufficiently burned, and free from pebbles, calcinable by the heat that burned the bricks; yet we muſt not deny, that extreme colds may be able to ſhatter or diſſolve the texture of as cloſe and ſolid bodies as bricks, eſpecially if the aqueous moiſture be not ſufficiently driven away; if we will admit, what I remember I have mentioned in another treatiſe, out of a very learned and credible author, of the power, that a freezing degree of cold has had to break even ſolid marble. And much leſs ſhall we doubt the poſſibility of what the phyſician related, if we will not reject the teſtimony of the learned *Olaus Wormius*, according to which, inſtruments made even of ſo hard a metal as braſs are not privileged from the deſtructive operations of ſome degrees of cold. For, *Ex ære facta opera* (ſays he in his curious Lib. 1. *Muſæum) vi frigoris quandoque rumpuntur, quod tamen pauci credunt, id tamen expertus* Sect. 3. *eſt Eratoſthenes, & noſtras Johannes Munckius in difficillimo ſuo itinere, quo per fretum* pag. 122. *Chriſtianum tranſitum in mare Auſtrale invenire moliebatur.* To which, perhaps moſt writers would, if they met with it, add this paſſage out of the Dutch-mens voyage to *Nova Zembla:* ‘ The 20th (of *October*) it was calm ſunſhiny weather, and then again ‘ we ſaw the ſea open, at which time we went on board, to fetch the reſt of our beer

‘ out of the ſhip, where we found ſome of the barrels frozen in pieces, and the iron ‘ hoops, that were upon the joſam barrels, were alſo frozen in pieces.’ But though this teſtimony ſeems to prove, that extreme cold may break even iron itſelf, and though poſſibly ſuch an affirmation might in the general not be erroneous, yet I ſhall forbear to draw that inference from this paſſage, becauſe I ſuſpect, that ſince the irons, that were broken, were hoops, and ſince it ſeems probable by the ſtory, that there were barrels not hooped with iron broken alſo by the ſame froſt; the breaking of the hoops may have been the effect, not of the violence of the cold, as acting immediately upon the iron, but of the liquor in the veſſels, which being, by the cold that froze it, turned into ice, was ſo forcibly expanded, as to burſt whatever oppoſed its dilatation, according to what we ſhall have occaſion in its due place more fully to deliver.

### *An Appendix to the* VI*th title.*

INQUIRING of the formerly mentioned phyſician to the Ruſſian emperor, what experience teaches about ſome of the matters treated of in this (ſixth) title, in thoſe cold climates, where the effects of freezing are more notable; he told me, that the tradition (mentioned above, touching the ſafeſt way of thawing) is in *Muſcovy* generally received; and that it is uſual for men, that have their cheeks and noſes frozen, to rub them well with ſnow, and eſcape unharmed; whereas if they go immediately into their ſtoves, they often loſe the tops of their noſes, and introduce into their cheeks a kind of paralytick diſtemper, or benumbedneſs, that they cannot get rid of in many months.

AND having alſo inquired of the ſame ingenious perſon, whether wine frozen, and then permitted to thaw, till the unfrozen liquor had quite reſolved the ice, was not thereby ſpoiled by having its texture vitiated, he anſwered, that in very ſtrong claret-wine he found the colour ſcarce at all deſtroyed, nor the liquor otherwiſe much impaired; but that in weaker claret-wine the colour was ſpoiled, and the liquor was otherwiſe much the worſe. But note, that in the French wine there remained a third part or more unfrozen, ſo that it ſeems not to have been expoſed to near ſo extreme a cold, as that of the Hollanders, or of captain *James*; and that phyſician likewiſe told me, that of ſome very ſtrong beer, that he had in great part frozen, the ice had ſome taſte of the hops, but was diſpirited like phlegm.

HAVING inquired how long dead bodies would keep, he told me, that if they were thoroughly frozen, they would be preſerved incorrupted till the thaw, though that perhaps might not happen within four or five months after the death of the man. He added, that he had the veniſon of elks ſent him unſalted, and yet untainted, out of *Siberia*, (which is ſome hundreds of leagues diſtant from *Moſcow*) and that beef and other fleſh well frozen, would keep unputrified for a very long time. And when I aſked, whether the freezing did not impair it, he anſwered, that with long keeping it congealed, it will grow very dry and be impaired in taſte, and will not make ſo good broth as meat that was never frozen. And he further told me, that in caſe frozen meat were leiſurely thawed, it would be far the leſs impaired, and might be well roaſted, but if before it was thawed, it were laid down to the fire, it would not ever be well roaſted, and would eat very ſcurvily: and though a ſhoulder of mutton, for inſtance, were kept very many hours turning before the fire, yet it would continue raw in the middle.

HAVING inquired about the rubbing bodies with ſnow to unfreeze them, he told me (agreeable to what I noted him to have ſaid above) that he had ſeen ſeveral perſons, that had been frozen, and that when a man is told, that he is frozen, and having aſked whereabouts (for the party himſelf uſually knows it not) is informed, that it is in this, or that place, which is commonly the noſe or the upper part of the cheek, or perhaps the tip of the ear; he uſually rubs the part very well with ſnow, and lets it thaw by degrees; elſe, if without that preparation he ſhould go immediately into the ſtove, he would be in danger to loſe his noſe, or other frozen part. The doctor added, that they uſe to rub the frozen meat and fiſh with ſnow, and that he once examined a man, who in his youth had been frozen all over, and informed the doctor, that having had occaſion in a journey to quit his ſled for a while, and do ſome exerciſe, that had almoſt made him ſweat, being careleſs of himſelf, when he returned to the ſled again, he was frozen all over, and had ſo died, had not the company by accident taken notice of him, and by rubbing him over with ſnow, and by the uſe of the like means recovered him again; but he told the doctor, that by this whole accident he was put to no pain, ſave that when he came to himſelf again, he felt ſuch a pricking all his body over, as men are wont to find in an arm or leg benumbed, by having been long leaned upon.

When I aſked, whether the ſharpneſs of the cold did not work upon the ſtones, he anſwered, that as to flints he could not tell; but as to other ſtones, and ſuch as are oftentimes uſed for building, the violence of the cold made them frequently moulder into duſt. And to ſatisfy my curioſity about the effect of cold upon wood, he told me, that he had very often in the night, eſpecially when their keen froſts were unaccompanied with ſnow, heard the trees cleave and crack with very great and ſometimes frightful noiſes; and that the outſide of the fir-trees, that were laid upon one another in their buildings, and was expoſed to the air, would do the like; and that he had often ſeen the gaping clefts ſometimes wide enough to put in his fingers, which would remain in the trees, and in the fir-wood, till the thaw, after which they would pretty well cloſe of themſelves.

## TITLE VII.

### *Experiments touching the expanſion of water, and aqueous liquors, by freezing.*

1. THAT water and other liquors are condenſed by cold, and ſo much the more condenſed, by how much the greater the degree of cold is that condenſes them, has been for many ages generally taught by the ſchools, and taken for granted among men, till of late ſome more ſpeculative than the reſt, have called it in queſtion upon the account of the levity of ice; ſince which, I have met with two modern writers, that have incidently endeavoured to prove, that ice is water, not condenſed, but rarified by the intumeſcence of water expoſed to freezing in veſſels fitly ſhaped.

The attempts of theſe learned men putting me in mind of what I had tried to this purpoſe, when I was ſcarce more than a boy, invited me to conſider, that by the uſual ways of glaciation, ſuch as theſe ingenious men employed, the experiment is wont to meet with a diſaſter, by the breaking of the glaſſes, which not only makes the event liable to ſome objections of theirs, that befriend the common opinion, but (which is more conſiderable) hinders them from judging what this expanſion of water, that is made by freezing, may amount to. Wherefore we will now ſet down what we have done to aſcertain (and yet limit) the experiment, as alſo to advance it further.

Nicholaus Zucchius, & Melchior Cornæus.

2. Whereas then theſe two learned men, we have been mentioning, do ſo expoſe the water to freeze, that it is turned into ice at the top as ſoon as elſewhere; the inconveniencies of which way, we have already noted; we, by freezing the water, as we have formerly taught from the bottom upwards, can eaſily preſerve our glaſſes intire, and yet turn the whole contained water into ice: ſo that if according to this way you ſo place a bolt-head or a glaſs-egg, in whoſe cavity the water aſcends to the

height of an inch, or thereabouts, within the ſtem or ſhank, in a mixture of ice, or ſnow and ſalt, as that the water is firſt turned into ice at the bottom and ſides, and not till the very laſt at the top, you ſhall manifeſtly ſee, that the ice will reach a good way higher in the neck, than the fluid water did, and that upon a gentle thaw of the ice, the water it returns to, will reſt at the ſame height in the ſtem, to which it reached, before it was expoſed to be frozen.

3. We have likewiſe uſed other ways unſpoken of by the lately mentioned writers, to evince, that water is expanded by being frozen; at firſt, that we took a ſtrong earthen veſſel of a cylindrical form, and filling it with water to a certain height, we expoſed it unſtopped, both to the open air in froſty nights, and to the operation of ſnow and ſalt, and found that the ice did manifeſtly reach higher than the water did, before it was congealed.

Besides, if a hollow pipe or cylinder, made of ſome compact matter, be ſtopped at one end with wax, or ſome things elſe, which it may be more eaſy to drive out, than to burſt the cylinder; and if at the other end it be filled with water, and that orifice alſo be ſtopped after the ſame manner; this pipe, ſuſpended in a ſufficiently cold air, will have the included water frozen, and by that change, if the experiment have been rightly made, the water will upon congelation take up ſo much more room than it did before, that the above-mentioned ſtopples, or at leaſt one of them, will be thruſt out, and there will be produced a rod of ice a good deal longer than the pipe, at each of whoſe ends (or at leaſt at one of them) a cylindrical piece of ice of a pretty length may be broken off, without meddling with the pipe, or the ice that fills it.

Divers other ways of proving the ſame truth might be here alledged, but that, though theſe were not, as they are, ſufficient, the matter would yet be abundantly confirmed by divers of the experiments, that will here and there come in more opportunely in the following part of this treatiſe.

4. But here it will not be altogether impertinent or unſeaſonable to take notice, that not only thoſe ſchool-philoſophers, who have conſidered the breaking of well-ſtopt glaſſes in froſty weather, (an accident but too frequent in apothecaries ſhops, and laboratories) but divers modern virtuoſi, are wont to aſcribe the phænomenon to this, that the cold of the external air, contracting the air and liquor within, the ambient air muſt break the ſides of the glaſs to fill that ſpace, which being deſerted upon the condenſation of the included air, the liquor would otherwiſe leave a vacuum abhorred by nature; and even thoſe few moderns, that are loth to aſcribe this phænomenon to nature's abhorrency of a vacuum, either not being acquainted with the weight of the air, know not what probable account to give of it; or if they acknowledge that weight, are wont to aſcribe it to that, and to the great contraction of the internal air, made by the cold of the external.

5. But as for the Peripateticks, the above-mentioned experiments ſufficiently evince, that in many caſes, it is not the ſhrinking, but the expanſion of the liquors contained in the ſtopt veſſels, that occaſions their burſting; and therefore in theſe caſes, we need not, nor cannot fly to I know not what *fuga vacui* for an account of the phænomenon. And whereas it may be objected, that even glaſſes not half full of diſtilled waters, if they be exactly ſtopt, are often broken in apothecaries ſhops: I anſwer, That neither in this caſe do I ſee any need of having any recourſe, either to the *fugi vacui*, or to the weight of external air; for even here the expanſion of the freezing liquor may ſerve the turn; for in ſuch inartificial glaciations the liquor begins to freeze at the top, and there generated, faſtening it ſelf (as on other occaſions we declare) very ſtrongly to the ſides of the glaſſes, contiguous to its edge, as the liquor freezes deeper and deeper, this cruſt of ice increaſes in thickneſs and ſtrength, ſo that

the water is included, as in a veſſel hermetically ſealed betwixt this ice at the upper part, and the ſides and bottom of the glaſs every where elſe; and conſequently, the remaining water being uncapable of congelation without expanſion, when the ice is grown ſtrong enough at the top, to make it eaſier for the expanſive endeavour of the freezing water to crack the ſides or bottom of the glaſs, than to force up that thick cake of ice, the veſſel will be broken, how much ſoever there be of it empty above the ſurface of the ice. And this conjecture may be confirmed by theſe two particulars: the one, that when water is frozen in a broad veſſel, which is too ſtrong to be broken or ſtretched by the froſt, the ſurface of the ice contiguous to the air will be convex or protuberant; becauſe, that though the glaciation began at the top, the thickneſs and compactneſs of the veſſel makes it eaſier for the expanſive endeavour to thruſt up that cake of ice in thoſe parts of it, that are the remoter from the ſides, whereunto they are ſtrongly faſtened, than to break ſo ſolid a veſſel.

6. THE other particular is afforded us by that experiment of ours, (mentioned in the fifth title foregoing) wherein if a veſſel half full of water be made to freeze, not firſt at the top, but at the bottom, that liquor may be turned into ice without danger to the glaſs. But we will now add an experiment, on whoſe occaſion we have ſet down thoſe conſiderations. For being inclined to think, that the ſpring of the air, ſhut up in a veſſel ſtopped, will preſerve it expanded, or at leaſt keep it from conſiderably ſhrinking, notwithſtanding a very great degree of cold, in caſe the veſſel be ſtrong and cloſe enough to fence it from the preſſure of the external air; we conjectured that the bare weight of the outward air, added to the refrigeration of the included air, would not be ſufficient to break much weaker glaſſes, than thoſe we have been ſpeaking of. And therefore partly to ſatisfy ſome ingenious men, that this conjecture made me diſſent from, and partly to ſhew the Peripateticks, and thoſe that adhere to them in the queſtion under conſideration, that either the cold alone cannot always, as they teach us, contract the air, or that, if it do, the breaking of well-ſtopped glaſſes in froſty weather is much fitter to evince, that there may be a vacuum, than that there can be none, we made the following experiment.

7. WE took three glaſs-bubbles of differing ſhapes and ſizes, which we cauſed to be blown with a lamp, that, to make the experiment very favourable for our adverſaries, we might have them much thinner, and conſequently, weaker than thoſe glaſſes, that are wont to be made uſe of to keep liquors in, and which, notwithſtanding, are wont to be broken, though they be not full, by the froſt.

THESE bubbles, when the air was at a convenient temper within, were (as eaſily they might be) nimbly ſealed up with care, to avoid the heating of the air in them; and being afterwards expoſed ſometimes to the air it ſelf in very froſty weather, and ſometimes to that greater cold, which is produced by the placing them in a mixture of ſnow and ſalt, we could not nevertheleſs find, that any one of three was at all broken or cracked; ſo that in caſe the included air were condenſed into a leſſer room, the ſpace it deſerted may be concluded empty, or elſe it will hardly appear, what neceſſity there can be, that nature ſhould break, as the Peripateticks pretend, very much ſtronger glaſſes in apothecaries ſhops, to prevent a vacuum.

8. HAVING ſhewn, that water it ſelf acquires a conſiderable expanſion by cold, we will next ſhew, that aqueous bodies, or thoſe that abound with wateriſh parts, do divers, if not all of them, the like.

WE took eggs, and expoſing them to a ſufficient degree of cold, we obſerved, that when the contained liquors were turned into ice, they burſt the ſhells aſunder; ſo that divers gaping cracks were to be ſeen in them, as long as they continued frozen.

9. Milk, urine, Rheniſh-wine, and good ſpirit of wine, being ſet to freeze in diſtinct glaſs eggs, neither of the three former liquors was obſerved to ſubſide before it began to freeze. The event in ſum was, that the urine was much longer, than either of the two other liquors, before it began to ſwell, but roſe to a far greater height, than they, afterwards. The wine did not leave the mark above an inch beneath. The milk aſcended about two inches, and the urine by gueſs ſix or ſeven.

10. A strong ſolution of *Dantzick* vitriol being put into a cylindrical pipe, ſealed at one end ſo, that the liquor filled the pipe to the height of about ſix or eight inches, being frozen with ſnow and ſalt, the congealed liquor grew very opacous, and looked as if it had been turned or ſhot into a vitriol, ſave a little, that remained fluid, and tranſparent near the bottom. And this ice, as appeared, roſe conſiderably higher than the liquor did before congelation.

It were perhaps worth trying, whether or no even ſeveral bodies of a ſtable conſiſtence, and durable texture, might not be found to receive ſome, though leſs manifeſt dilatation by exceſſive cold. And methinks thoſe, who attribute glaciation to the plentiful ingreſs of frigorifick atoms into bodies, ſhould by their hypotheſis have been invited to make ſome trials of this kind, ſince we ſee, that the inviſible moiſture of the air againſt rainy weather does ſeem manifeſtly enough to alter the dimenſions of doors, window-ſhutters, and other ſuch works made of wood not well ſeaſoned. And even without ſuppoſing the truth of the Epicurean hypotheſis, if we conſider, that in bread, though we are ſure, that much more water was added to the meal, or flower, than was exhaled in the oven, yet there appears not the leaſt drop of water diſtinct in the concrete, and that hartſhorn, ſponges, and many other bodies, that ſeem very dry, will afford by diſtillation good ſtore of phlegm or water, and more than can probably be aſcribed to any tranſmuting operation of the fire: if, I ſay, we conſider theſe and the like things, it may ſeem worth while to try (which I want the conveniency to do) by accurate meaſures, whether the inviſible and interſperſed water, its comminution notwithſtanding, will not upon freezing ſwell the body, that harbours it. And I would the more gladly have been ſatisfied in this, becauſe I hoped it might help me to unriddle a ſtrange phænomenon, afforded us by the narrative of the Dutchmen's voyage to *Nova Zembla*, wherein they relate, ‘ that the cold was ſo great, that their ‘ clock was frozen, and would not go, though they hung more weight upon it than ‘ before:’ ſo that they were fain to meaſure their time by hour-glaſſes. For though this odd effect might be ſuſpected to proceed from ſome little icicles ſticking to ſome of the wheels, or the line, in regard they not far off tell us, that the ſteams of their bodies, and other things within their cloſe houſe*, did ſo faſten themſelves to the walls, to the roof, and even to their cabins, as to line them with ice, of no leſs than two fingers thick; yet beſides that it cannot be probably ſuppoſed, that they, who had ſo great need of their clock, during the tedious abſence of the ſun for many weeks together, ſhould not all the winter long be aware of this; beſides this, I ſay, I find, that in captain *James*'s wintering at *Charleton*, his clock and watch were ſo frozen too, ‘ that they could not go, notwithſtanding they were ſtill kept by the fire-ſide in a ‘ cheſt, wrapt in cloths.’ Page 64. So that in caſe it appear, that, according to what we formerly noted out of *Wormius*, the froſt can get into metals, it can alſo diſtend them, and other ſtable bodies: we might conceive, that the ſtopping of the clocks might proceed from the ſtiffneſs, or the ſwelling of the line, to which the weight was faſtned, or a ſwelling even of ſome of the wheels, or other metalline parts of the clock, that may ſpoil the neceſſary congruity between the teeth, *&c.* as I have tried, that ſome parts of an iron inſtrument, I cauſed to be made, would by no means fit one within another, when expanded by much heat, (and though cold be the cauſe of the expanſion, the effect may be the ſame) though at other times they would. And if we knew, whether ſprings loſe any thing of their elaſticity by the violence of the cold, we might thence alſo be aſſiſted to gueſs, whether the froſt's operation upon the ſpring of captain *James*'s watch (for he mentions that, as diſtinct from his clock) might contribute any thing to the forcing it to ſtand ſtill. But theſe are bare conjectures, from which I will therefore paſs on to the following ſection.

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* It froze ſo ſore within the houſe, that the walls and the roof thereof were frozen two fingers thick with ice, and alſo in our cabins, where we lay all thoſe three days, while we could not go out. *Gerat de Veer* in his third Voyage.

## TITLE VIII.

### *Experiments touching the contraction of liquors by cold.*

1. BUT notwithſtanding all the former experiments, we muſt not conclude univerſally, that all liquors are diſpoſed to be expanded by cold, neither by a moderate degree, nor even by ſo intenſe a degree of it as ſuffices to freeze or congeal the liquors expoſed to it. This we have tried, not only in ſpirit of wine, aqua fortis, oil of turpentine, and divers other liquors, that we could not bring to freeze, but alſo in oil congealed by the vehemence of cold; ſo that as to the change of dimenſions produced in liquors by cold, there muſt be a great difference allowed betwixt water and aqueous liquors on the one ſide, and oil and divers other liquors, that are ſome of them of an oleaginous, and ſome of a very ſpirituous, or very highly corroſive nature, on the other ſide. Nor have we yet made trials enough to reduce this matter to a certainty. For though we could not bring ſome ſtrong ſaline ſpirits, nor the moſt of chymical oils to freeze; yet in ſome our attempts ſucceeded not ill. But I remember not, in any liquor we could by cold produce any ſenſible expanſion, but rather a manifeſt condenſation, unleſs we could bring it actually to freeze.

2. THE trials we made of the efficacy of cold to condenſe liquors, were many; but it may, for the preſent, ſuffice to ſet down two or three differing ones, that occur to us in our collections.

To the entry of the experiment lately recited, of the expanſion of milk, urine, and the Rheniſh wine, there are ſubjoined theſe words:

[BUT the egg, that held the ſpirit of wine, though it were much ſmaller than we uſually employ, and fitted with a proportionably ſlender ſtem, and though it were kept divers hours partly in ice and ſalt, and partly in ſnow and ſalt, yet it froze not at all, but ſubſided by degrees below the firſt mark to the quantity of $\frac{3}{4}$ of an inch in the ſtem; and though it afterwards ſeemed to riſe a little, yet it never ſwelled up again to the ſaid firſt mark.]

3. WE took a round bolt-head of about      in diameter, and poured in mercury till it reached a pretty way into the neck, which was purpoſely drawn more ſlender than ordinary; and having, without approaching it to the fire, freed it from ſome of the larger bubbles of air, that appeared at the ſides, we put it into a mixture of ice and ſalt, where the cold ſo wrought upon it, that watching it attentively, we could diſcern not only its having moved, but its motion downwards, which it continued (though not viſibly in the progreſs, as at the firſt) till it was ſubſided in the neck two inches or better, which was far more than could be attributed to the contraction of any ſenſible aërial particles, though they had loſt not only the 30th part of their

dimenſions, as we have ſometimes obſerved of the air, but had been contracted to a point; and we obſerved too, that the quickſilver once thus infrigidated, though not frozen, retained ſome of the acquired cold, for many hours after, as appeared by its keeping below the mark of its firſt height, though we had kept it all night in a warm room.]

[4. We took a ſmall egg with a proportionably ſlender ſtem, into which we poured common oil, till it roſe a pretty way (but not much) above the oval part of the glaſs; then having put a mark upon the ſtation of the liquor, we placed the veſſel in ſnow and ſalt, and obſerved it not to ſwell as other liquors, but to ſubſide, with cold; till being quite frozen or congealed, it appeared to be ſhrunk about an inch or more beneath the mark; then being thawed, it ſwelled again to the mark.]

5. The experiment was repeated the ſecond time, with not much worſe ſucceſs; but we found, that if the glaſs were removed out of the ſnow into ſome place near the fire, the hot air would not only thaw it, but ſo rarify it, as to make it aſcend above the mark. A third time we ſealed up the ſame oil in the ſame glaſs, and repeated the experiment, with like ſucceſs to that we had the ſecond time; and that the frozen oil was really condenſed, we found, becauſe it would ſink in oil of the ſame kind, cold, but unfrozen; and this, notwithſtanding divers bubbles, which we obſerved uſually to be made about each lump of congealed oil, that we caſt in, upon its beginning to ſink in the fluid oil. This we tried, both with oil well congealed (or if another word pleaſe better, incraſſated or curled) by ſnow and ſalt, and with oil leſs congealed, frozen by the bare cold of the ambient air; but this latter ſeemed, to ſight, to ſink more ſlowly than the other, and being leſs congealed and ponderous, yet would not lumps of the maſs of oil ſink or continue immerſed. I ſay, not in common water, but in ſack or claret wine; and if thruſt down into either of theſe liquors, they nimbly enough emerged.

6. Whether or no chymical oils, though, like expreſſed oils, they ſhrink with a moderate degree of cold, would by congelation be, like them, contracted, or like aqueous liquors, expanded, we could not ſatisfy ourſelves by experiment, becauſe we were unable to advance cold to a degree capable of bringing ſuch oils to congelation; only we had thoughts to make a trial with oil of aniſeeds, diſtilled with water in a limbeck, in regard, that though it be a very ſubtile liquor, and, as chymiſts call it, an *eſſential* oil; and though in the ſummer-time, and at ſome other ſeaſons (if the weather be warm) it will remain fluid; yet in the winter, when the air is cold, it will, if it be well drawn, and genuine, eaſily enough loſe its fluidity; and therefore we thought it might do well to pour ſome of it, in moderate weather, into a conveniently ſhaped glaſs, and then to freeze it externally by the application of ice and ſalt, that we might obſerve, whether upon congelation it would ſhrink or be expanded. And accordingly, though we were not provided with any quantity of this oil, yet in weather, that was not ſharp, we did, by the help of ſome ice, which we procured, when the ſeaſon made it a rarity, ſurround a glaſs pipe filled with fluid oil of aniſeeds, and found, though the pipe were but ſhort, yet the incloſed ſubſtance, when it had loſt its fluidity, had conſiderably loſt of the height, which it reached to before.

7. And becauſe the empyreumatical oils, that are driven out of the retorts by ſomewhat violent fires, ſeemed to be of a nature differing enough from thoſe eſſential oils (as artiſts call them) which are drawn in limbecks by the help of water as well as fire; and becauſe we obſerved, that ſome of the firmer oils may be uſed in phyſick, in much larger doſes than it is thought ſafe to give the latter in: conjecturing from

hence, that probably empyreumatical oils may be leſs hot, and ſo leſs indiſpoſed to congelation, we thought fit to make trial (no body elſe in probability having done it) whether the cold in our climate could be brought to freeze theſe oils, and whether it would expand or condenſe them. Wherefore expoſing, in conveniently ſhaped veſſels, ſome good oil of guaiacum, that was diaphanous enough, though very highly coloured, to the greateſt cold we could produce, we attempted, but in vain, to deprive it of its fluidity; all that we were able to effect, being to make it very manifeſtly ſhrink.

## TITLE IX.

### *Experiments in conſort, touching the bubbles, from which the levity of ice is ſuppoſed to proceed.*

1. SINCE the firſt thing, that made the moderns ſuſpect, that water is expanded by freezing, is the floating of ice upon water; it will not be amiſs, for confirmation of that argument, to take ſome notice of the levity of ice in reſpect of water. This is beſt obſerved in great quantities of ice; for whereas in ſmall fragments or plates, the ice, though it ſink not to the bottom of the water, will oftentimes ſink ſo low in it, as ſcarce to leave any part evidently extant above the ſurface of the water, in vaſt quantities of ice, that extancy is ſometimes ſo conſpicuous, that navigators in their voyages to *Iceland*, *Greenland*, and other frozen regions, complain of meeting with lumps, or rather floating rocks of ice, as high as their main-maſts. And if we ſhould meet with caſes, wherein we might ſafely ſuppoſe the ice to be as ſolid as entire pieces of ice are wont to be with us, and not to be made up of icy fragments cemented together, with the interception of conſiderable cavities filled with air, it would not be difficult for any, that underſtands hydroſtaticks, to give a pretty near gueſs at the height of the extant part, by the help of what we lately obſerved of the meaſures of water's expanſion, and by the knowledge of the immerſed part; which ſuppoſing, that the ice were of a priſmatical figure, and floated in an erected poſture, would, in freſh water, amount to about eight or nine times the length of the part of the priſm ſuperiour to the ſurface of the water.

2. BUT becauſe perhaps the great diſparity in the degrees of cold, whereby water is in this, and in thoſe gelid climates turned into ice, may breed a difference in the expanſion of the frozen water; and becauſe ſome other circumſtances may be needful to be taken into conſideration, about the height of floating ice above water, and theſe will be more properly taken notice of under the following title; I ſhall only upon this head (*of the levity of ice*) ſubjoin the enſuing tranſcript of one of our notes concerning that ſubject.

[WE found, that pieces of ice, clear and free, for aught the eye could take notice of, from bubbles, would not be made to ſink in ſpirit of wine once diſtilled from brandy, and it floated likewiſe in ſtrong ſpirit of wine drawn from quick-lime; but if the ſpirit of wine were well warmed, ſuch ice, as I mentioned, would ſink in it, though as it grew cold, the ſame ice would ſlowly aſcend, and ſometimes remain for a while, as if it were ſuſpended without ſenſibly riſing or falling. But all this while the ice, thawed apace in the water, whereinto it was diſſolved, did manifeſtly ſeem to run down like a ſtream through the lighter body of the ſpirit of wine, the diverſity of the refractions making this eaſy to be taken notice of; yet common water, though heated as hot as I could endure to hold the glaſs in my hand, would not let the fragments of the ſame parcel of ice ſink into it; but in oil of turpentine, and in thrice rectified ſpirit of wine, the ice would ſink like a ſtone.]

3. That the levity of ice, in reſpect of water, proceeds from the bubbles, that are produced in it, and make the water, when congealed, take up more room than when fluid, has ſcarce been doubted by any, that has conſidered the texture of ice, as well as taken notice of its levity. But if this be the true and only reaſon, we may conjecture, that there muſt be great ſtore of bubbles in ice, extremely minute, and undiſcerned by the naked eye. For though in very many parcels of ice, the bubbles are as well conſpicuous as numerous, inſomuch that they render the ice whitiſh and opacous, yet we have obſerved, that other pieces would ſwim, which yet were of an almoſt cryſtalline clearneſs. And therefore we thought fit to look upon ſome clear pieces of ice in a microſcope, and we ſhall ſubjoin the event, becauſe that when we beheld ſome of this ice in one of our microſcopes, which has been counted by ſeveral of the curious, as a good magnifier, as perhaps any is in the world, we could not diſcover ſuch ſtore of bubbles, as it ſeemed there ſhould appear upon the ſuppoſition, that the adequate cauſe of the levity and expanſion of frozen water is but the interſperſion of ſuch bubbles.

The obſervations I have been mentioning, I find thus ſet down among my notes.

[A piece of ice, that to the eye looked clear like cryſtal, being put into the great microſcope, appeared even there free from bubbles; and yet the ſame piece of ice being preſently removed, and caſt into common water, would ſwim at the top, and, if it were forcibly ducked, would ſwiftly enough emerge.

Another piece of ice, that to the naked eye was not ſo clear as the former, appeared in the ſame microſcope to have ſtore of bubbles, ſome of them appearing there no bigger than a ſmall pin's head, and ſome of them being yet leſſer, and ſcarcely viſible in the microſcope itſelf.]

And here, becauſe it ſeems a conſiderable doubt, and well worth the examining, whether or no water, when frozen into ice, grows heavier or lighter, not in reference to ſuch water as it was generated of, (ſince it is evident, that upon that it will float) but more abſolutely ſpeaking, we judged it not amiſs to examine this matter by an experiment; but we could not diſcover any difference between the weight of the ſame parcel of water fluid and frozen, as will appear by the ninth paragraph of the experiment to be a little beneath recited.

But ſince that, whether or no we allow any other cauſe, together with the bubbles, to the levity of ice, it ſeems a thing not to be doubted, that its expanſion and lightneſs is mainly, if not only, due to the interſperſion of bubbles, the generation of them ſeems to be one of the conſiderableſt phænomena of cold, and the inveſtigating by what cauſe thoſe cavities are produced, and in caſe they be perfectly full, what ſubſtance it is that fills them, is none of the meaneſt enquiries, that ſhould exerciſe the induſtry of a ſearcher into the nature of cold.

4. Mr. *Hobbes*, and ſome others ſeem to think, that the expanſion of water by congelation, is cauſed by the intruſion of air, which conſtitutes thoſe numerous bubbles wont to be obſerved in ice; we might here demand, why in caſe, that upon freezing there muſt be a conſiderable acceſſion of air from without, when oil is frozen, it is, notwithſtanding the ingreſs of this air, not expanded, but condenſed: but becauſe theſe conjecturers do not allow glaſs to be pervious to common air, we ſhall at preſent preſs them with this experiment, which we have divers times made.

We took a glaſs-egg with a long ſtem, and filling it almoſt with water, we ſealed it hermetically up, to exclude the pretence that ſome adventitious air might get in, and inſinuate itſelf into the water, and yet ſuch an egg being expoſed to congelation, the frozen water would be manifeſtly expanded, and ſwelled by numerous bubbles, which oftentimes gave it a whitiſh opacity.

To which we may add, that new metalline veſſels being filled with water, and carefully ſtopped, the liquor would nevertheleſs, when expoſed to the cold, be thereby expanded, and turned into ice furniſhed with bubbles.

5. If it be objected, that in the experiment of the hermetically ſealed glaſs, the produced bubbles might come from the air, which being ſealed up together with the water, might, by the expanſion of that water, be brought to mingle with it: I anſwer, that this is very improbable. For 1. if the bubbles muſt cauſe the expanſion of the water, how ſhall the water be at firſt expanded to reduce the air to a diviſion into bubbles? Next, it is evident by the experiments we ſhall ere long relate, that the air, as to the body of it, retains its ſtation above the water, and preſerves itſelf together in one parcel, ſince it ſuffers a compreſſion, that oftentimes makes it break the glaſs that impriſons it, which it would not need to do, in caſe it diſperſed it ſelf into the body of the water; for then there would appear no cauſe, why the air and water ſhould after congelation require more room than they did before. 3. In this experiment we uſually begin to produce ice and bubbles in the water, contiguous to the bottom of the veſſel (that part being by the ſnow and ſalt firſt refrigerated) in which caſe there appears no reaſon, why the air, which is a thouſand times lighter than the water, ſhould againſt its nature dive to the bottom of the water: and if it were diſpoſed to dive, why ſhould we not ſee it break through the water in bubbles, as is uſual in other caſes, where air penetrates water? 4. In metalline veſſels, and in glaſſes quite filled with water, before they are ſtopped, there is no pretence of the diving of the air from the top, there having been none left there. 5. And laſtly, if all the bubbles of ice were made by, and filled with true air deſcending from the upper parts of the veſſels, and only diſperſed through the waters; then, upon the thawing of this ice, the air would emerge, and we might recover as much of the real air as would fill the ſpace acquired by the water upon the account of its being turned into ice, which is contrary to our experience. And this argument may alſo be urged againſt any, that ſhould pretend, (for I expect not to ſee him prove it) that though air, as numerous experiments evince, cannot get out of a ſealed glaſs, yet it may in ſuch a caſe as this, get into it. But we find upon trials, that the cavities of theſe bubbles are not any thing near filled with air, if they have in them any more air at all, than that little, which is wont, as we have elſewhere ſhewn, to lurk in the particles of water, and other liquors. And the making good of this leads us to the ſecond enquiry, we were propoſing about theſe bubbles; namely, whether or no their cavities be filled, and filled with air.

6. The full reſolution of this whole difficulty would be no eaſy matter, nor well to be diſpatched with ſo much brevity as my occaſions exact. For it would require ſatisfactory anſwers to more than one or two queſtions, ſince, for aught I know, it may lead us to the debate of thoſe two grand queries, whether or no nature admit a vacuum, and whether a great part of the univerſe conſiſt of a certain etherial matter, ſubtile enough to paſs through the pores, not only of liquors, but of compact bodies, and even of glaſs itſelf. We ſhould alſo be obliged to enquire, whether or no air, I mean true and permanent air, can be generated anew, as well out of common water, as many other liquors, and whether it may be generated by cold itſelf; and perhaps we ſhould be obliged to inquire into the *modus* of this production, and engage

ourſelves in divers other difficulties, whoſe full proſecution, beſides that they would as much exceed our preſent leiſure, as abilities, ſeems more properly to belong to the more general part of phyſicks, where ſuch kind of general queſtions are fitteſt to be handled.

Wherefore we will now only conſider this particular queſtion, whether or no the cavities of the bubbles, wont to abound in ice, be filled with common air; and even this queſtion, though it ſeem but one, comprizes two: for to reſolve it, we muſt determine, whether there be any true air contained in thoſe cavities, and whether in caſe there be, they be adequately filled with that air, (by true air I mean ſuch an inviſible fluid, as does permanently retain a ſpring like the common air.)

7. The former of theſe two queſtions, I muſt confeſs myſelf not yet reſolved about, my experiments having not hitherto ſucceeded uniformly enough to ſatisfy ſo jealous an obſerver. But yet I ſhall annex our trials, not only becauſe the thing has not been, that we know of, ſo much as attempted by others, and our ways of experimenting, if they be duly proſecuted, ſeem as promiſing and hopeful (if the queſtion be reducible to any certain deciſion) as perhaps will be eaſily lighted on; but becauſe alſo we have, if we miſtake not, reſolved the ſecond queſtion, by ſhewing, that there is but a ſmall part of true air contained in the bubbles of ice, whatever ingenious men, that rely upon probable conjectures, without conſulting experience, have been pleaſed to believe to the contrary.

That the bubbles obſerved in ice cannot all be filled with the aërial particles lurking in the water, ſeems evident enough by the expanſion of the water, and the quantity of ſpace taken up by thoſe bubbles; which how the interſperſed, and formerly latitant air, can adequately fill, unleſs the ſame parcel of matter could truly fill much more ſpace at one time than at another, (which I take to be phyſically impoſſible) I do not yet apprehend.

But two ways of trial there are, which we employed to ſhew, that the icy bubbles are nothing near filled with true air, whether men will have that pre-exiſtent in the water, or ſtolen in from without, or generated anew; the former of the two ways of trials probably arguing, that theſe bubbles proceed not *only* (for that they may proceed *partly*, we do not at all deny) from the air pre-exiſtent in the water, and the latter concluding more generally, that but a ſmall part of the icy bubbles are filled with genuine air.

8. And 1. we were invited to conjecture, both, that ſometimes, or in ſome caſes, the air latitant in the water might contribute to generate icy bubbles, though it was unable adequately to fill them; and again, that ſometimes or in other caſes ſuch bubbles would be almoſt as numerouſly generated, notwithſtanding the receſs of far the greateſt part of that latitant air, by the three following experiments taken *verbatim* out of our collections.

I. We took fair water, and having kept it in the exhauſted receiver of our pneumatical engine for a good while, till we perceived it not to ſend up any more bubbles, we preſently transferred it into ſnow and ſalt, where it was long enough before it began to freeze; and then we obſerved, that the water did not ſwell near ſo much as common water is wont to do, and the ice ſeemed to have few or no bubbles worth taking notice of. But when I afterwards placed it between my eye and the vigorous flame of a candle, I could perceive, that it was not quite deſtitute of bubbles, though they were extremely ſmall, in compariſon of thoſe, that would probably have appeared in ordinary water.

Thus far the firſt experiment; the ſecond follows, which was made at another time.

II. THE water, that had been freed from the bubbles in the receiver, though it afforded an ice, that ſeemed to have ſmaller bubbles, yet this ice being thawed, part of the water was gently poured into a pipe of glaſs, wherein being frozen, it ſwelled conſiderably enough above its firſt level, and beſides burſt the glaſs, being alſo very opacous by reaſon of the bubbles.

THE third experiment was more induſtriouſly proſecuted, as may appear by this ample narrative of it, tranſcribed out of our Collections.

III. WE took a ſmall egg with a pretty long neck, and pouring in water till it reached an inch within the ſtem, conveyed it into a long ſlender cylindrical receiver, provided on purpoſe to make trials with ſuch tall glaſſes; the air being by degrees drawn out of the bubbles, appeared from time to time greater and greater, and when the receiver was well exhauſted, the water ſeemed to boil a longer time than one would have expected; and ſometimes the bubbles aſcended ſo faſt and great, that we were in doubt, whether the water did not boil over the top of the pipe. The exhauſted receiver was permitted to be ſo for a good while, till the water had diſcharged it ſelf in bubbles of its air, and then the glaſs-egg was removed into a veſſel furniſhed with ice and ſalt, and there left ten or twelve hours, that all the water, ſave that in the neck, might be throughly frozen; and then we found it to have riſen a great way above its firſt height: and removing it into an air tempered like that, wherein the firſt part of the experiment was made, and having left it there in a quiet place for ten or twelve hours to thaw leiſurely, (leſt too warm an air, or too much ſtirring the glaſs, might be an occaſion of generating new bubbles) in the exteriour part of the ice near the glaſs, we ſaw pretty ſtore of bubbles; but when that was thawed, the reſt of the ice appeared of a peculiar and unuſual texture, having no determinate bubbles, that I could eaſily diſtinguiſh, but ſeeming almoſt like a piece of froſted glaſs, where the parts, that made the aſperity, were exceeding thick ſet; but this ice ſwam in the water, whereinto the reſt had been diſſolved before it was all thawed. When there yet remained a lump about the bigneſs of a ſmall walnut, we reconveyed it into the receiver, to try whether, upon the exſuction of the air, the ice would be preſently melted; but the alteration produced was ſo ſmall, if any, that we durſt not ground any thing upon it. The receiver being exhauſted, there did at length appear ſome bubbles in the water, but they were not numerous, and a hundred of them ſeemed not to amount to one of thoſe larger ones, the ſame water had yielded us the firſt time it was put in. In the ice alſo ſome ſmall bubbles diſcloſed themſelves, which we did not perceive there before; wherefore we took out the egg, and found (the ice being now thawed) that the water was ſubſided to the mark we had made, before it was expoſed to congelation, if not ſome very little way beneath it. Then we went about to find the proportion, wherein this diſpirited water was expanded by glaciation; but in purſuing this, there happened a miſchance to the glaſs, which kept the experiment from being ſo accurate as we deſigned. And therefore, though it ſeemed to us, that it amounted to about the twelfth part, which is leſs than that of the undiſpirited water, yet we deſigned the repetition of the experiment. Only in this we could not be miſtaken, that the expanſion was conſiderable, ſince the water roſe three inches and a half in the ſtem, though the whole water in the egg and ſtem too weighed but two ounces and a half. If the veſſel had not been unluckily cracked, we ſhould have frozen the water once more; and then ſealing up the glaſs hermetically, and ſuffering the ice leiſurely to thaw, ſhould have inverted it, and broken it under water, and have proceeded with it as we had done with ſome other glaſſes in the formerly mentioned experiments.

9. [A LITTLE glaſs cylinder open only at one end, of a convenient length, was thruſt into a deep and wide-mouthed glaſs, about half filled with a mixture of ice and ſalt: but the cylinder was neither ſo quite filled, that the water ſhould run over, nor yet far ſhort of being ſo; that (for all the opacous mixture of ice and ſalt) we might gueſs at the freezing of that part of the water, that we could not ſee by the changes appearing in the other. Then conveying all into a receiver, that we had in readineſs beforehand, we quickly pumped out the air, upon which there came, both from the upper and lower parts of the water, great ſtore of bubbles to the top, where moſt of them brake into a receiver. Having found, upon trials purpoſely made, that the engine had continued ſtanch all the while, and perceiving by the intumeſcence of the ſuperiour parts of the water, that the other were frozen, we let in the external air, and having removed the receiver, and taken out the mixture, before the ice was half melted, we found the water, as high as the mixture reached, to be turned into ice, which, beſides ſome large and conſpicuous bubbles, had ſmall ones enough to render it opacous; and upon the account of this expanſion it was, that the water did in the free air continue a good deal higher than the mark, it was but level with, when the cylinder was expoſed to freeze.]

10. THE other way we employed to examine what was contained in icy bubbles, and which ſeemed clearly enough to manifeſt, that they are very far from being filled with true and ſpringy air, is intimated in the laſt clauſe of the foregoing narrative, but will be beſt underſtood by the annexed experiments, tranſcribed juſt as I find them regiſtered in my collections. And though they be prolix, and contain ſome few particulars, that make not directly for the purpoſe I alledge them for, yet I think not fit to diſmember or to epitomize them, or otherwiſe to alter any thing in them; partly, becauſe the way of experimenting being altogether new will be beſt apprehended by the ſubjoined examples; and partly too, becauſe thoſe particulars, that relate not directly to the occaſion of our mentioning theſe trials, may be uſeful to illuſtrate or confirm ſomething, that is already delivered, or is hereafter to be delivered in the preſent hiſtory of cold.

11. [WE took this day a glaſs of the form of an egg, but of double the capacity, out of whoſe obtuſe end roſe up a cylindrical neck, capable to receive the end of my little finger, and no more; this being filled with common water, till the liquor reached a pretty way within the pipe, and the ſurface of the water being carefully marked on the outſide, was placed in a veſſel, wherein ice very groſly beaten, was mingled with a convenient proportion of ſalt, (according to our way of glaciation) the mixture not reaching up to the mark by above an inch. The experiment afforded us theſe particulars.

Feb. 4, 1661.

I. A HEEDFUL eye did not perceive the water ſenſibly to ſubſide, before it began to freeze.

II. THE water began to ſwell, and ſome parts of it next the ſide or bottom of the glaſs, to freeze within a quarter of an hour.

III. THE aſcent of the water in the pipe increaſed ſo faſt, that within an hour, from the time the glaſs was put in, it did riſe four inches and $\frac{2}{9}$ above the mark; and afterwards the ſwelling continued ſo, that we took it out, though a good part of the water remained unfrozen, it had reached five inches and ſomewhat more than a half above the firſt mark.

IV. THE ice and ſalt being purpoſely kept always beneath the ſurface of the water, the lower parts of the water were frozen, and never the upper ſurface.

V. DURING all this great elevation of the water, there appeared no bubbles worth taking notice of in the unfrozen parts of the liquor, but the ice was very full of them, divers of which toward the latter end of the experiment were very large bubbles, (but not all of them round) ſome being about the bigneſs of hail-ſhot, ſome ſmall like muſtard-ſeed, and others again not much inferiour to little peaſe.

VI. HAVING taken out the glaſs, when the water was at the higheſt mark, we did, upon a certain deſign, pour in as much ſallet-oil as ſwam about two inches above it, and then the glaſs was nimbly at the flame of a lamp ſealed up, during which time the included water ſubſided a little; but the glaſs being again put into the ice and ſalt, the cold quickly reſtored the water to its former height, and there remained about an inch and half of the ſealed glaſs unpoſſeſſed by the two contained liquors.

VII. THEN with a good pair of ſcales we weighed the glaſs-egg firſt in the air, and then in the water, (the better to diſcern, whether any ſhrinking of the glaſs intervened in the caſe) where it hung freely, and was left hanging in its æquilibrium with its oppoſite weight.

VIII. WHILST it thus hung, upon the thawing of the ice many bubbles great and ſmall aſcended (the great ones with a wriggling motion) and vaniſhed at the top.

IX. As the ice thawed, the water and oil deſcended, till the whole ice was returned to water; at which time we obſerved theſe two remarkable things; the one, that the æquilibrium remained the ſame; the other, (which was more conſiderable) that the water was ſubſided again as low as the firſt mark, with which it was level before it began to ſwell, without falling beneath it, notwithſtanding the receſs of ſuch a multitude of bubbles, divers of which were very large.

X. THE glaſs being inverted, the ſealed end, which was drawn ſlender, was gently broken under water, of which ſome, being impelled in, did ſenſibly reduce the air at the oppoſite end into a narrower room; and, as one of the ſpectators obſerved, into a much narrower, which is conſonant enough to reaſon.

XI. THE glaſs being again inverted, and held till it was ſettled, we found, that the water drawn in together with the water it found there, and the oil, poſſeſſed the ſame places, (as appeared by the marks in the cavity of the receiver) that they did, when it was ſealed up.

XII. AND laſtly, having thrown out the oil, and employing, where need was, a little water of the ſame kind we had made uſe of all this while, we found the glaſs filled to the higheſt mark, to weigh 4374 grains; when it was filled but to the loweſt mark, 4152 grains; and when quite emptied, 1032. So that the water contained betwixt the higheſt and loweſt mark, and raiſed by the glaciation, was about a fifteenth part of the water ſet to freeze; and probably would have amounted to much more, if the water had been all frozen.

Dec. 11, 1662. 12. [A LARGE glaſs-egg being taken with a proportionably big ſtem, we poured water into it, till it reached about an inch above the bottom of the ſtem, and faſtening a mark there, we expoſed it all night to freeze in ſnow and ſalt; which was ſo placed, as not to reach ſo high as the bottom of the ſtem. The next day about ten of the clock we found the water riſen in the ſtem about 15 inches above the mark, the whole cylinder of water being fluid by reaſon of the ſnow's not reaching to it. (Then upon a deſign, to be elſewhere mentioned, we ſealed up the glaſs by a very ſlender pipe, that had been before purpoſely drawn out to a pretty diſtance from the body of the cylinder, that the glaſs might be ſealed in a trice, before the flame of a candle could ſenſibly rarify the air, and after a while we broke off the apex of this ſlender pipe in proſecution of our former deſign) Then ſuffering the water to ſwell freely, within ſeven or eight hours it reached the very top of the glaſs, a drop or two running over at the ſlender orifice thereof; ſo that in all, the water aſcended about 19 inches above the firſt mark. Then we tried by the flame of a candle to ſeal the glaſs, but by reaſon of the rarifaction of ſome of the water, by the heat, into vapours, by which ſome of the other water was, from time to time, ſpurted againſt the flame of the candle, we found it troubleſome enough to ſeal it up, the veſſel being removed into a warm place, till next morning; and all the ice in the belly of it (for the water in the ſtem continued fluid) being thawed, the water ſubſided, not only to its firſt mark, but a little beneath it, by reaſon of that which was thrown out, upon occaſion of the ſealing of the glaſs. But when we came to invert this, after the manner above mentioned, into a veſſel of water, to ſee how much of the ſpace deſerted by the thawed ice was filled with air, and how much was filled with a ſubtiler ſubſtance, or empty, juſt then a miſchance fruſtrated our expectation.]

13. [An egg about the ſame bigneſs with the former was placed to freeze in beaten ice and ſalt, and in leſs than an hour, it was riſen near an inch above the mark, where the ſurface of the water was at the firſt, and the water in the ball and the joining of the neck was frozen into *laminæ*. After an hour and a quarter, thoſe *laminæ*, that before appeared in the beginning of the neck, now diſappeared; but the ball ſeemed frozen into a white ice, and the water in the neck was riſen above the firſt mark four inches and a half. There now appeared abundance of ſmall bubbles, continually aſcending through the neck, (which ſo continued all the time after, till it was quite thawed) and the white ice appeared full of bubbles. The experiment being further purſued, the water aſcended higher and higher, till it had reached about eight inches above the firſt mark: then the top of the pipe being with a lamp drawn out into a very ſlender cylinder (for the conveniency of ſealing up) the glaſs was again put into the ice, that the air heated by the lamp might cool; upon which the water continued ſwelling, till it began to run over at the orifice of the ſlender pipe, which being held by, in the flame of a candle, was in a trice ſealed up; ſo that the whole glaſs appeared full of water; bating an inconſiderable quantity of rarified air, (not amounting to the bigneſs of half a ſmall pea) that remained contiguous to the ſealed part. The egg being brought into a warm room, was kept there all night, and a good part of the next morning, before the ice was quite thawed; which when it was, the water was found ſubſided to the firſt mark, and which being done, the glaſs was inverted, and the ſealed end immerſed a good way under water; where being broken, the external air impelled the water in the baſon into the cavity of the pipe, inſomuch, that when we took it out, which we did, as ſoon as we thought no more water was impelled up, reinverting the glaſs, we found, that the admitted water reached ſeven inches above the firſt mark, and left an inch and an half of the ſtem, before it began to be wire-drawn, beſides as much of the ſlender part of the ſtem, as by gueſs amounted to a quarter of an inch more: ſo that it ſeemed, that the bubbles, which made the water ſwell, and appeared in the ice, amounted to an inch and three quarters of air, which conſequently ſeemed to be for the moſt part generated by this operation, and to ſeven inches either of a vacuum, or ſome ſubtile ſubſtance, which by its having no ſpring to reſiſt the preſſure of the outward air, appeared not to be air. We could not exactly meaſure the quantity of water we had in all, and the proportion of it betwixt the marks, becauſe having left the glaſs in the window, to try whether time or cold would make the admitted water ſhrink, (which we did not find it to do) the weather was too ſharp, that beginning (as we concluded) to freeze the water in the ſtem, the increaſing ice burſt out the belly of the glaſs into many pieces.] Decemb.

*Another time.*

14. [A ſealed glaſs being broken under water, there was impelled into the cylinder ten inches and a little above a half. And the mark it ſhould have riſen to, was eleven inches and a quarter above the firſt and loweſt mark.]

*Another time.*

Decemb. 15. [IN the ſame bolt-head, wherein the greateſt condenſation of the air was tried, the water was by the cold made to ſwell very near a foot above the mark it reſted at, when it began to freeze; then the glaſs being nip'd up, the contained water was removed, and ſuffered leiſurely to thaw, and upon the diſſolution of the ice, the water fell back to the former mark. Laſtly, the glaſs being inverted, the apex was broken off under water, and the water in the ſtem was, by the outward air preſſing upon the water in the baſon, with ſome impetus and noiſe driven up into the cavity of the glaſs; and, the glaſs being ſeaſonably and warily removed from the baſon, we found there had been impelled up of the water in the baſon, a little more than eleven inches; ſo that there ſeemed to be near ⅞ of an inch of air generated or ſeparated by the former operation.]

*Another time.*

Decemb. 17. 16. IN the ſame glaſs we made the water to ſwell about ten inches, and inverting the ſtem, and breaking the neb under water, we found about ten inches of water to have been impelled into the ſtem; ſo that in this there ſeemed no generation of air.]

17. To all theſe experiments we ſhall ſubjoin, in two words, that as in water, ſo in ſome aqueous liquors we found, that the icy bubbles were not filled with air (though we did not think fit to take the pains to meaſure their reſpective expanſions by being congealed:) for in that elſewhere mentioned experiment, where we expoſed milk, urine, and Rheniſh-wine to freeze, when all thoſe liquors were riſen above their former marks, as is there related, our notes inform us, that the experiment was thus proſecuted.

18. [BEING ſealed up (the foregoing words mentioned the above-named expanded liquors) and ſuffered to thaw, the ſeveral liquors ſubſided to their firſt marks or thereabouts, and the glaſſes being inverted and broken under water, we were, by an accident, hindered from obſerving what we deſired in that, which had the wine, though when it was taken out of the freezing pot, it had ice, but not much, ſwimming in it. But into the glaſs, that had the milk, the water was manifeſtly impelled by the outward air; and ſo it was into the glaſs, that had the urine, which being removed from the baſon, and reinverted, appeared to have as much new liquor in its ſtem, as amounted by gueſs to five or ſix inches.]

19. To which experiment we may add, that another time a ſealed glaſs of partly frozen claret-wine being broken under water, the water was impelled up between half an inch and an inch above the mark, beyond which it would not have aſcended, if the bubbles had been full of true and permanent air.

20. IF it be ſaid, that though I have delivered too many particulars about ſo empty and ſlight a theme as bubbles, I have this to anſwer, that poſſibly all theſe experiments have rather ſhewed us, what it is not, that fills them, than what it is; ſo that more than all theſe experiments appearing requiſite to clear up the difficulties about them, I ſhall not think I have altogether miſ-ſpent my time, eſpecially if ſo many paſt experiments, both new, and not altogether impertinent, by their not having taught us enough about ſo deſpicable a ſubject as a bubble, ſhall, as they juſtly may, teach us humility.

## TITLE X.

*Experiments about the meaſure of the expanſion and the contraction of liquors by cold.*

1. TO the experiments (mentioned in the ſeventh and ninth titles) which ſhew, that water has an expanſion, it will be proper to ſubjoin ſome of thoſe whereby we endeavoured to meaſure that expanſion. And here we ſhall not content ourſelves to ſay, that whereas the authors we had formerly occaſion to point at, take notice of their having raiſed water in a bolt-head half an inch or an inch by freezing, we have made it aſcend a foot and a half and more; this, I ſay, we ſhall paſs by, becauſe that though by ſuch experiments we have very clearly and undeniably manifeſted the expanſion of the water, yet unleſs the capacity of the veſſel be known, they will ſignify but little towards the determining the quantity of that expanſion, which yet is the thing we are enquiring after: wherefore we ſhall add, that we employed two differing ways to meaſure this expanſion.

2. THE one was, by putting in, by weight, ſuch a number of ounces of water into a bolt-head, till the water was riſen a pretty way in the long ſtem wherewith it was filled; then marking on the outſide, to what height every freſhly added ounce of water reached in the ſtem, we afterwards poured out a convenient quantity of the liquor, (yet leaving enough to fill the whole cavity of the ſpherical or obtuſe end of the veſſel, and of the lower part of the ſtem) then leiſurely freezing this remaining water from the bottom upwards, we obſerved, that when it was frozen, the ice, that was made of 82 parts of water, filled, as one of our notes inform us, the ſpace of 91, and (if I miſtake not the character) an eighth; ſo that by this troubleſome way of examination, we found, that the water, by the expanſion it received from cold, was made to poſſeſs about a ninth part more ſpace than it did before congelation.

[3. IN another of our notes, we find as follows, 55 parts of water extended themſelves by freezing into 60 and ½, about 6 of thoſe parts remaining unfrozen; ſo that in this experiment the water's expanſion was not much (though ſomewhat) differing from what it was in that laſt mentioned.]

4. THE other way we made uſe of to meaſure the dimenſions, that water gains by freezing, was to take a cylindrical pipe of glaſs, ſealed at one end, and left open at the other; at which we filled it with water to a certain height, that we took notice of, by a mark applied to the outſide, and then keeping it in an erected poſture, and freezing it from the bottom upwards, we found, that it had acquired by a tenth part, or thereabouts, greater dimenſions in the form of ice, than it poſſeſſed in the form of water. But the nature of the particular parcel of liquor expoſed to the cold, (for it is not neceſſary, that all waters ſhould be equally diſpoſed to be expanded by freezing) and ſome other circumſtances, not now to be diſcourſed of, may well beget ſome little variety in the ſucceſs of this ſort of trials. For in one, that we made carefully, we found the expanſion ſomewhat greater, than that laſt mentioned, as may appear by the following note; which, compared with what was lately delivered, of the trials we made by weight of the water's expanſion, may invite us to think, that we cannot much err by eſtimating in general, that the room, that ice takes up more than water, amounts to about a ninth part of the ſpace poſſeſſed by the ſame water, before it was turned into ice. The note we were ſpeaking of, is this:

[5. In a more than ordinarily even cylindrical glaſs, we expoſed ſome water to freeze, to meaſure its intumeſcence, and found, that it expanded itſelf to about an eighth part, or at leaſt a ninth upon glaciation; this we tried twice, and thought, that the intumeſcence might have been more conſiderable, but that in a cylinder the freezing did not ſeem to ſucceed ſo well.]

But here we muſt reſolve a difficulty, which, though ordinary readers may take no notice of, yet may breed a ſcruple in the minds of thoſe, that are acquainted with hydroſtatics. For to ſuch readers this account of ours may ſeem to be contrary to the experience of navigators into cold climates, who tell us (as we ſhall have occaſion to take notice of in due place) of vaſt pieces of ice, as high, not only as the poops of their ſhips, but as the maſts of them; and yet the depth of theſe ſtupendous pieces of ice ſeems not at all anſwerable to what it may be ſuppoſed to be, in caſe we compare together the eſtimate above delivered of the expanſion of water, and that grand hydroſtatical theorem demonſtrated by *Archimedes* and *Stevinus*, 'That floating 'bodies will ſo far, and but ſo far, ſink in the liquor, that ſupports them, 'till the immerſed part of the body be equal to a bulk of water, weighing as 'much as the whole body.' For Captain *James*, in his often-cited voyage, makes mention of great pieces of ice, that were twice as high as the top-maſt-head of his ſhip.

6. And the Hollanders, in their famous voyage to *Nova Zembla*, mention one ſtupendous hill of ice; which I therefore take notice of here, not only becauſe it has been thought the greateſt, that men have met with, but becauſe they deliver its dimenſions, not as Captain *James* and navigators are wont to do, by compariſon with the unknown heights of ſome of the maſts of their ſhips, but by certain and determinate meaſures, which, in the icy iſland we are ſpeaking of, were ſo divided by the ſurface of the water, that there was 16 fathom extant above it, though there were but 36 beneath it: which, though a vaſt depth in itſelf, yet does but little exceed double the height.

Barthol. de nivis uſu, Cap. 6.

And the Daniſh navigator *Janus Munckins*, employed by his king to bring him an account of *Greenland*, mentions ſome floating pieces of ice, that he met with and obſerved in that ſea, which, though but ſomewhat above 40 fathom under water, were extant 20 fathom (that is, near half as much) above water; whereas it ſeems, that, according to our above-mentioned computation of the expanſion of water, the part under the water ought to be eight or nine times as deep as that above the water is high.

7. To clear this difficulty, I ſhall repreſent theſe three particulars:

First, that in our computation, the ice, that ſinks ſo deep, is ſuppoſed to float in freſh water; whereas, in the obſervations of the above-named navigators, thoſe vaſt pieces of ice floated on the ſea-water, which by reaſon of its ſaltneſs, being heavier than freſh water, ice will not ſink ſo deep into that, as into this. And that ſalt may hugely increaſe the weight of the water, wherein it is diſſolved, may be clearly gathered from the ponderouſneſs of common brine, and from the practice of ſeveral ſorts of tradeſmen, who, to examine the ſtrength of their lixiviums, and other ſaline liquors, are wont to try, whether they will keep an egg floating, which we know common water will not do. And I have alſo, by the reſolution of ſome metalline bodies in fit menſtruums, made liquors, that are yet much more ponderous, than is ſufficient for the ſupport of eggs.

But yet we muſt be ſo candid, as to take notice of what ſome modern geographers deliver with probability enough; namely, that nearer the poles the ſeas are not wont to be ſo ſalt, as in the temperate and the torrid zones: and thoſe northern being not ſo ſalt as our ſeas, there is the leſs to be allowed for the difference in gravity (and conſequently in the power to keep ice from ſinking) betwixt thoſe ſeas and ours.

8. But ſecondly, this leſſer ſaltneſs of the water in the northern ſeas may, as to our caſe, be recompenſed by the greater coldneſs of it. For though, as we have formerly obſerved, the condenſation of freſh water, effected here by a degree of cold capable to make it begin to freeze, is not ſo great as moſt men would imagine; yet beſides that I have often taken pleaſure to make the ſame body to ſink or aſcend in the ſame water, by a much leſs variation of cold than that we have been mentioning; it is to be conſidered, that the degree of cold, to which water was brought in the experiment delivered in the fourth ſection, to which we are now looking back, was but ſuch a degree, as would make freſh water begin to freeze: whereas the ſalt ſea-water, being indiſpoſed to congelation, may, by ſo vehement a cold as reigns in the winter-ſeaſon in thoſe gelid climates, be far more intenſely refrigerated, and thereby more condenſed than common water is here, by ſuch a meaſure of cold, as may begin to freeze ſmall portions of it. But though what we have hitherto repreſented, may well be looked upon as not inconſiderable to the purpoſe, for which it has been alledged, yet the main thing, that is to remove the ſcruple ſuggeſted by the height of icy hills above the water, is,

9. Thirdly, that ſuch hills of ice are not to be looked upon as intire and ſolid ones, but as vaſt piles or lumps, and maſſes of ice, caſually and rudely heaped up and cemented by the exceſſive cold, freezing them together by the intervention of the water, that waſhes them; which piles of many pieces of ice are not made without great cavities intercepted, and filled only with air, between the more ſolid cakes or lumps: ſo that the weight of theſe ſtupendous pieces of ice is not to be eſtimated by the bigneſs they appear of at a diſtance from the eye, but conſidering how much air there is intercepted between the icy bodies, of which they are compiled, there may be a hollow ſtructure of ice reaching high into the air, and yet the whole aggregate or icy pile, will preſs the ſubjacent water on which it leans, no more than would as much water, as were equal in bulk only to the immerſed parts; as we ſee in barges loaden with boards, which, though piled up to a great height above the water, make not the veſſel to ſink more than a lading, that would make a far leſs ſhew, and oftentimes be all contained within the cavity of the veſſel, provided it be more ponderous *in ſpecie*. But to enter into any further conſideration of theſe hydroſtatical matters, would be improper in this place, eſpecially ſince we have * elſewhere treated of them. And that theſe floating hills and iſlands of ice are not intire and ſolid pieces of it, we ſhall otherwhere have occaſion to ſhew out of navigators, and even in the obſervation we have mentioned out of *Janus Munck*, the learned relator of it. *Bartholinus* takes notice, that thoſe vaſt pieces of ice (we have been mentioning) that reached 20 fathom above water, were compiled of ſtore of ſnow frozen together.

* In our Hydroſtatical Paradoxes.

Ex nive copioſa glaciata compacta.

10. These conſiderations may ſerve to render ſome account of thoſe ſtupendouſly tall pieces of ice, whoſe extant parts bear ſo great a proportion to the immerſed part, when the whole maſs does really float. But I confeſs I doubt, that not only in the examples we have alledged, but in other eminent ones of mountains of ice, if I may ſo call them, there may be a miſtake; and that the height of them above the water would be far leſs, and the depth under water far greater, if the ice had water enough to ſwim freely. For ſeamen, by reaſon of the difficulty, are not wont to meaſure the height of thoſe pieces, that float at liberty in the ſea. And as for thoſe, that are on ground, as their heights lie far more convenient to be meaſured, ſo the meaſurers not

knowing how long they have been on ground, for aught I know, much of that admired height may be attributed to the ſnows, that from time to time fall very plentifully in thoſe frozen regions, and are compacted together, either by the ſun, whoſe beams ſometimes begin to thaw it, and ſometimes by the water of the waves that beat againſt the ice, and being congealed with the ſnow, does as it were cement the parts of it together, and ſometimes by both of theſe cauſes. So in the inſtance alledged out of Captain *James*, page 14. of pieces of ice, that were twice as high as his topmaſt-head; it is ſaid alſo, that they were on ground in 40 fathom. And in the other example mentioned out of *Bartholinus*, though there be 40 fathom attributed to the immerſed part of the ice, yet that meaſure is not excluſive of a greater; for it is ſaid, that the ice reached downwards above 40 fathom; and how much downwards, and whether as far as the ground, we are left at liberty to gueſs. And in that ſtupendous piece of ice recorded in the *Nova Zembla* voyage, to have been in all 52 fathom, that is 300 and twelve foot deep, though it be granted what they affirm, that it was 16 fathom above the water, which is almoſt a third part of the whole depth; yet I obſerve, that of this icy mountain it is ſaid, that *it lay faſt on the ground.* So that as on the one ſide it ſeems probable, that the upper part of iſlands of ice may be increaſed by ſnow; and, as I remember, that in that famouſly inquiſitive navigator Mr. *Hudſon*'s voyage for the diſcovery of the North-weſt paſſage, it is related, that his company was * ‘ſo well acquainted with the ice, that when night, or foggy or ‘foul weather took them, they would ſeek out the broadeſt iſlands of ice, and there ‘come to anchor, and run and ſport, and fill water that ſtood on the ice in ponds ‘very freſh and good.’ So on the other ſide we know not, how much lower the Dutchmen's ice and Captain *James*'s would have reached into the ſea, in caſe the ground they reſted on, had not hindred them. For though one might probably think, that theſe are the greateſt depths, that any hills of ice have been obſerved to attain, (that mentioned by the *Hollanders* reaching 36 fathom beneath the water, and that mentioned by Captain *James*, no leſs than 40 fathom) yet I find in Mr. *Hudſon*'s voyage, that the Engliſh, in the bay that bears his name, met with more than one or two iſlands of ice, of a far greater depth under water. For among other things, the relator has this memorable paſſage; ‘In this bay, where we were thus troubled ‘with ice, we ſaw many of thoſe mountains of ice aground, in ſix or ſeven ‘ſcore fathom water.’ And if the ſea had been deep enough, even theſe ſtupendous moles of ice would probably have ſunk much lower, and ſo have leſſened the heights of the mountains.

11. I KNOW, that delivering the meaſure of the expanſion of water alone I have not ſaid all, that may be ſaid about the expanſion of liquors; but becauſe, as it has not yet appeared to me, that any liquor is expanded by cold, unleſs by actual freezing; I doubted, whether aqueous liquors, as wine, milk, urine, *&c.* were otherwiſe expanded by congelation, than upon the account of the water or phlegmatick (and, in a ſtrict ſenſe, congealable) part contained in them; and whether it were worth while, for a man in haſte, to examine their particular expanſions. Notwithſtanding which, I would not diſcourage any from trying, whether or no, by the differing dilations of aqueous liquors, ſome of them of the ſame, and ſome of them of differing kinds, we may be aſſiſted to make any eſtimate of the differing proportions they contain, of phlegm, and of more ſpirituous or uſeful ingredients.

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* Mr. Hudſon's voyage for the diſcovery of the North-weſt paſſage, written partly by Mr. Abacuck Pricket.

12. After what has been hitherto delivered concerning the expanſion of liquors by cold, it may be expected we ſhould ſay ſomething of the meaſure of their contraction by the ſame quality. But as for water, which is the principal liquor whoſe dimenſions are to be conſidered, I have formerly declared, that I could ſeldom or never find its contraction (in the winter ſeaſon when I tried it) to be at all conſiderable. And I ſhall now add, that having, for greater certainty, procured the experiment to be made by another alſo, in a bolt-head, the account I received of it was, that he could ſcarce diſcern the water in the ſtem to fall beneath its ſtation, (marked at the upper part of the pipe) when the water in the ball was ſo far infrigidated as to begin to freeze. Though I will not deny, that in warmer climates, as *Italy* or *Spain*, the contraction of the water, a little before glaciation begins, may be ſomewhat conſiderable, eſpecially if the experiment be made in ſummer, or in caſe (either there or here) the water expoſed to freeze be put into a veſſel very advantageouſly ſhaped, or brought out of ſome warm chamber or other place, where the heat of the air, that ſurrounded it, had rarified it. But to examine the meaſures of contraction in the ſeveral liquors, and with the nice obſervations, that ſuch a work, to be accurately proſecuted, would require, would have taken up much more of my time than I was willing to imploy about a work, which I looked not on as important enough to deſerve it. And therefore I ſhall here add nothing to what I have ſaid under the title of the *Degrees of Cold*, touching the contraction of ſpirit of wine and oil of turpentine, by the differing degrees of that quality; and as for the condenſation of air, the vaſteſt fluid we deal with, I did indeed think fit to meaſure how much cold condenſes it. But the account of that experiment will be more opportunely delivered in * one of the following diſcourſes.

* In the ſect. about the temperature of the air.

## TITLE XI.

### *Experiments touching the expanſive force of freezing water.*

1. HAVING ſhewn, that there is an expanſion made of water, and aqueous bodies, by congelation, let us now examine how ſtrong this expanſion is, and the rather becauſe no body has yet, that we know of, made any particular trials on purpoſe to make diſcoveries in this matter: ſo that although ſome unhappy accidents have kept our experiments from being as accurate as we deſigned, (and as, God aſſiſting, we may hereafter make them) yet at leaſt we ſhall ſhew this expanſion to be more forcible, than has hitherto been commonly taken notice of, and aſſiſt men to make a ſomewhat leſs uncertain eſtimate of the force of it, than they ſeem to have yet endeavoured to enable themſelves to make.

2. And (1.) we ſhall mention ſome experiments, that do in general ſhew, that the expanſion of freezing water is conſiderably ſtrong.

We took a new pewter bottle, capable to contain, as we gueſſed, about half a pint of water, and having filled it top full with that liquor, we ſcrewed on the ſtopple, and expoſed it during a very froſty night, to the cold air; and the next morning the water appeared to have burſt the bottle, though its matter were metalline, and though purpoſely for this trial we had choſen it quite new, the crack appeared to be in the very ſubſtance of the pewter. This experiment we repeated; and it was one of thoſe bottles filled with ice, that had cracked it, which a noble virtuoſo would need make me (who ſhould elſe have ſcrupled to amuſe, with ſuch a trifle, ſo great a monarch, and ſo great a virtuoſo) bring to his Majeſty, to ſatisfy him, by the wideneſs of the crack, and the protuberance of the ice, that ſhewed it ſelf in it, that the water had been really expanded by congelation.

3. We alſo tried, whether or no a much ſmaller quantity of water would not, if frozen, have the like effect; and accordingly, filling with about an ounce of water a ſkrewed pewter box (ſuch as many uſe to keep treacle and ſalves in) quite new, and of a conſiderable thickneſs, we found, that upon the freezing of the included water, the veſſel was very much burſt.

Afterwards filling a quart bottle (if I miſtake not the capacity) with a congealable liquor, and tying down the cork very hard with ſtrong packthread, we found, that the froſt made the liquor force out the ſtopple, in ſpite of all the care we had taken to keep it down.

But afterwards we ſo well faſtened a cork to the neck of a quart bottle of glaſs, that it was eaſier for the congealed liquor to break the veſſel, than to thruſt out the ſtopple; and having for a great many hours expoſed this to an exceeding ſharp air, we found at length the bottle burſt, although it were ſo thick and ſtrong, that we were invited to meaſure the breadth of the ſides, and found that the thinneſt place, where it was broken by the ice, was $\frac{3}{16}$ of an inch, and the thickeſt $\frac{3}{8}$, that is, twice as much: we alſo by the help of the froſt broke an earthen bottle of ſtrong *Flanders* metal, of which the thinneſt part, that was broken, was equal, by meaſure, to the thinneſt part of the other.

4. But the above mentioned inſtances ſerving only to declare in general, that the expanſion of water by cold is very forcible, I thought fit to attempt the reducing of the matter ſomewhat nearer an eſtimate leſs remote from being determinate; and becauſe the water expoſed to congelation may be probably ſuppoſed to be homogeneous, we judged, that the quantity of it, may very much vary its degree of force; and becauſe ſome may ſuſpect, that the figure alſo may not be inconſiderable in this matter, we thought fit to make our trials in a braſs veſſel, whoſe cavity was cylindrical, and which, to make it ſtronger, had an orifice but at one of its ends; and whoſe thickneſs was ſuch, that we had reaſon to expect, that whilſt the top remained covered, but with a reaſonable weight, the included water would find it more eaſy to lift up that weight, than break the ſides. To this cylinder we fitted a cover of the ſame metal that was flat, and went a little way into the cavity, leaning alſo upon the edges of the ſides for the more cloſe ſtopping of the orifice: the cavity of this cylinder was in length about five inches, and in breadth about an inch and three quarters. This cylinder being filled top-full with water, and the cover being carefully put on, was faſtened into an iron frame, that held it erected, and allowed us to place an iron weight, amounting to 56 pound, or half a hundred of common Engliſh weight; which circumſtance I mention (becauſe the common hundred, that our carriers, *&c.* uſe, exceeds five ſcore by twelve.) But this veſſel being expoſed in a froſty night to the cold air, the contained water did not the next morning appear to be frozen, and the trial was another time that way repeated with no better ſucceſs, as if either the thickneſs or clearneſs of the metal had broken the violence of the external air's frigefactive power, or the weight, that oppreſſed the cover, had hindered that expanſion of the water, which is wont to accompany its glaciation.

Wherefore we thought it requiſite to apply to the outſide of the veſſel a mixture of ſalt, with ice or ſnow, as that, which we had obſerved to introduce a higher degree of cold than the air alone, even in very froſty nights; and though this way it ſelf, the glaciation proceeded very ſlowly, and ſometimes ſcarce at all, yet at length we found, that the water was by this means brought ſo far to freeze, that on the morrow ice had on one ſide ſwelled above the top of the cylinder, and by lifting the cover on that ſide, had thrown down the incumbent weight; but in this trial the cover having been uniformly, or every where lifted up above the upper orifice of the cylinder, we repeated the experiment divers times, as we could get opportunity, ſometimes with ſucceſs, and ſometimes without it; and of one of the chief of our experiments of this ſort, we find the following account among our collections.

5. [THE hollow braſs weight, being about one inch and three quarters in diameter, and the braſs cover put on, was loaded with a weight of 56 pound upon the cover and expoſed to an exceſſively ſharp night: the next morning the cover and the weight were found viſibly lifted up, though not above (that we could diſcern) a ſmall barley-corn's breadth, but the thickneſs of the braſs cover was not here eſtimated, which was much leſs than half an inch, which, according to former obſervations, one might expect to ſee the ice aſcend. But that, which we took particular notice of, was, that the incloſed cylinder of ice, being by a gentle thaw of the ſuperficial parts taken out, appeared ſo full of bubbles, as to be thereby made opacous. Alſo when in the morning the cylinder was brought into my chamber, before the fire was made, the 56 pound weight being newly taken off, at a little hole, that ſeemed to be between the edge of the braſs and ice, there came out a great many drops of water, dilated into numerous bubbles, and reduced in a kind of froth, as if upon the removal of the oppreſſing weight the bubbles of the water had got liberty to expand themſelves; but this laſted but a little while.]

6. AFTER this the difficulty we have often met with in the placing of great weights conveniently upon the cover of a cylinder, and the expectation we had to find the quantity of the water we made uſe of, capable, upon its congelation, to lift up a much greater weight, invited us to make trial of its expanſive force, by ſomewhat a differing way; which was, to fit a wooden plug to the cavity of the cylinder, (after we had ſuffered it to ſoak a convenient time in water, that, ſwelling as much as it would before, it might be made to ſwell no more by the water, which would lie contiguous to it in the veſſel) and then to drive it forcibly in, till by conſiderable weights appended to the extant part of the plug, when the cylinder was inverted, we could not draw it out. The ſucceſs of one of theſe trials is thus ſet down in our collections:

7. [A PLUG was driven into the cavity of a braſs cylinder, firſt filled with water, the plug being alſo well ſoaked; then the cylinder being inverted, the plug took up half a hundred and a quarter of a hundred weight, and would poſſibly have taken up much more, and being expoſed to a very ſharp night, the freezing water thruſt out the plug about a barley-corn's breadth, quite round above the upper edge of the cylinder; and it freezing all that day and the next night, it was again expoſed, the plug not being yet taken out, and then the plug was beaten out a little more, namely, (in all) near a quarter of an inch.]

8. THUS we ſee, that the expanſive endeavour of the water forced a reſiſtance, at leaſt equal to that, which would have been made by a weight of 74 pound; and probably, as the note intimates, would have appeared able to do more, if we had had convenient weights and inſtruments, wherewith to have meaſured the ſtrength of the water's endeavour outwards, which ſome ſubſequent trials made us think very conſiderable; though not finding their events ſet down in our notes, we think it fit at preſent to leave them unmentioned.

BUT one thing there is in theſe trials, that I think not unworthy a philoſopher's notice, and his conſidering; namely, that this endeavour of the water to expand it ſelf is thus vigorous, though the uttermoſt term, to which it would expand it ſelf, in caſe it were not at all reſiſted, would be but to about a ninth, or at moſt an eighth part of the ſpace it poſſeſt before it began to freeze; whereas air may by heat (which yet, we have * elſewhere ſhewn, will not reduce it to any thing near its umoſt expanſion) be brought to poſſeſs (though not to fill) according to the diligent † *Merſennus*'s obſervation, ſeventy times the dimenſions it had before rarifaction; and conſequently the air expanded by heat does by its endeavours tend to acquire above 60 times the ſpace, that the water does, when expanded by ſo high a degree of cold, as is capable to turn it all into ice: not to mention, that the expanſion, to which the air tends upon the account of its own ſpring, is (as we ſhew in another ‡ place) many times greater than that, to which *Merſennus* could bring it upon the bare account of heat.

9. THERE remains yet one way, whereby we hoped, though not to meaſure the expanſive force of freezing water, yet to manifeſt it to be prodigiouſly great; or in caſe we failed of this aim, to produce at leaſt ſome other phænomena relating to cold, that would not be inconſiderable. And though our endeavours ſucceeded not, yet becauſe a happier opportunity may bring them to be one way or other ſucceſsful, we ſhall annex, that we cauſed to be made an iron ball of between two and three inches diameter; which ball was ſolid, ſave that in the midſt there was a ſmall cavity left to place a little water in, together with a female ſcrew, as they call it, reaching from the outward ſurface of that internal cavity; and to this was applied a ſtrong iron ſcrew, ſo fitted to the internal cavity of the other ſcrew, as to fill it with as much exactneſs as could be obtained. And this ſcrew was made to go ſo hard, that it required to be ſcrewed in by the help of a vice, that it might not be forced out, without breaking the iron it ſelf. Our deſign in imploying this inſtrument was, that having well filled the internal cavity with water, and forced in the ſcrew as far as it could be made to go, the inſtrument thus charged with water might be expoſed to the higheſt degree of cold we could produce. For having thus ordered the matter, we thought we might expect, either that the water, how much ſoever we heightened and lengthened the cold, would not freeze at all, being hindered from the expanſion belonging to ice in compariſon of water; or, if it did freeze, that one of theſe two things would happen, either that the expanſive force of that little water would, by forcing ſuch an iron inſtrument, manifeſt its ſtrength to be ſtupendous; or, by not breaking it, preſent us with ice without bubbles, or at leaſt not rarer and lighter, than the water it was made of: but for want of a ſufficient cold, our deſigns ſucceeded not, ſo as to ſatisfy us, though we more than once attempted it. For the great thickneſs of the iron being conſidered, we were not ſure, that the waters not freezing might not proceed rather from the thickneſs and compactneſs of the metal, than from its reſiſtance to the expanſion of water. And therefore we muſt ſuſpend the inferences, this experiment may afford us, till we have opportunity to make trial of it, with a cold not only very intenſe, but durable enough; the want of which laſt circumſtance keeps us from daring to build any thing on our experiment.

10. AND here we may take notice, that it may be an inquiry, more worthy a philoſopher, than eaſy for him, whence this prodigious force, we have obſerved in water, expanded by glaciation, ſhould proceed. For if cold be but, as the Carteſians would have, a privation of heat, though by the receſs of that ethereal ſubſtance, which agitated the little eel-like particles of the water, and thereby made them compoſe a fluid body; it may eaſily enough be conceived, that they ſhould remain rigid in the poſtures, wherein the ethereal ſubſtance quitted them, and thereby compoſe an

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* New Experiments Phyſico-mech. Exper. 6.

† See the fore-cited place.

‡ The Appendix to the Phyſico-mechanical Experiments.

unfluid body like ice: yet how theſe little eels ſhould by that receſs acquire as ſtrong an endeavour outwards, as if they were ſo many little ſprings, and expand themſelves too with ſo ſtupendous a force, is that, which does not ſo readily appear. And on the other ſide, in the Epicurean way of explicating cold, though the phænomenon ſeems ſomewhat leſs difficult, yet it is not at all eaſy to be ſolved: for though, granting the ingreſs of ſwarms of cold corpuſcles, the body of water may be ſuppoſed to be thereby much ſwelled and expanded, yet beſides that theſe corpuſcles, ſtealing inſenſibly into the liquors they inſinuate themſelves into, without any ſhew of boiſterouſneſs or violence, it is not ſo eaſy to conceive, how they ſhould diſplay ſo ſtrange a force againſt the ſides of thoſe ſtrong veſſels, that they break, when they may as freely permeate or enter them: beſides this, I ſay, we obſerve, that in oil, which requires a far greater degree of cold to be congealed to a good degree of hardneſs, the ſwarms of frigorifick atoms, that invade it, are ſo far from making it take up more room than before, that they reduce it into leſs, as may appear by thoſe former experiments, which manifeſted, that cold does not expand, either oil or uncongealable liquors, but condenſe them.

11. After what I have thus largely delivered, concerning the expanſive endeavour of freezing water, I hope I may be allowed to leave to others (if they ſhall think it worth the labour) the proſecution of the like experiments upon wine, milk, urine, and other liquors abounding with aqueous parts; concerning which, we ſhall only in general remind thoſe, that may have forgotten it, that by ſome of our experiments it appears, that ſuch aqueous liquors are expanded by congelation, and that their endeavour outward is conſiderably forcible, ſeems more than likely from what we formerly noted out of the Dutch voyage to *Nova Zembla*, where it is related, that by the extreme cold, both ſome of their other barrels, and ſome of thoſe that were hooped with iron, were, as they ſpeak, frozen in pieces; that is, according to our conjecture, burſt together with the hoops, whether of wood or iron, by the expanſive force of the impriſoned liquors brought to freeze.

12. To which I ſhall add, that when I aſked an ingenious perſon, whether in *Ruſſia*, where he lived a good while, beer and wine did not, when brought to congelation, break the veſſels they were frozen in; he anſwered, that he had not obſerved wooden veſſels to have been broken by them, (perhaps becauſe of their yielding) but glaſs and ſtone bottles often.

## TITLE XII.

### *Experiments touching a new way of eſtimating the expanſive force of congelation, and of highly compreſſing air without engines.*

1. THERE is yet another way, that I bethought my ſelf of, at once to meaſure the force, wherewith freezing water expands it ſelf, and to reduce the air to a greater degree of condenſation, than I have as yet found it brought to by any unqueſtionable way of compreſſing it. But whereas by this method, to determine exactly the expanſive force of the water, it were requiſite not only to know the quantity of the water, and that of the air expoſed to the cold, but to make the experiment in veſſels conveniently ſhaped to meaſure the dilatation of the one, and the compreſſion of the other; our experiments being made in a place, where we were not provided of ſuch glaſſes, we were not able to make our trials ſo inſtructive and ſatisfactory, as elſe we might have done. Nevertheleſs, we ſhall not ſcruple to ſubjoin thoſe of them, that we find noted down among our collections, allowing our ſelves to hope, that they will not be unacceptable or appear impertinent, not only upon the account of their novelty, but for two other reaſons,

2. THE firſt, becauſe though they do not accurately define the expanſive force of freezing water, yet they manifeſt, that it is wonderfully great, better perhaps than any experiment, that has been hitherto practiſed, (not, to ſay, thought of) as may appear by comparing what we have delivered in another treatiſe, of the great force requiſite to compreſs air conſiderably, with the great compreſſion of air, that has already been this way effected.

3. THE ſecond, becauſe this new way affords us one of condenſing the air much farther than hitherto it has, by any method I have heard of, been unqueſtionably reduced; I ſay, unqueſtionably, becauſe though the diligent *Merſennus*, and others, ſeem to have conceived himſelf to have reduced it in the wind-gun into a very narrow room; yet beſides that, by our expedient, we have compreſſed it beyond what theſe ingenious men pretend to; beſides this, I ſay, I have long much queſtioned, whether the way of compreſſing air in a wind-gun, which both they and we have imployed, may ſafely be relied on. For the oil or ſome other analogous thing, that is wont this way to be employed, and the overlooking of ſeveral circumſtances, that are more neceſſary to be taken into diligent conſideration, than wont to be ſo, may eaſily enough occaſion no ſmall miſtake in aſſigning ſo great a degree to the compreſſion of the air; but our exceptions againſt this way of meaſuring it may be more opportunely diſcourſed of in another place. And therefore we will now proceed to take notice, that of the two known ways of compreſſing air, the cleareſt and moſt ſatisfactory ſeems to be that, which is performed in the wind-fountain, as it is commonly called, where yet I have ſeldom, if ever, ſeen the air, (that I remember) by all the violence men could uſe to ſyringe in water, crouded into ſo little as the third part of the capacity of the veſſel. And an ingenious artificer, that makes ſtore of theſe fountains, being conſulted by me, about the further compreſſing of air in them, he deterred me from venturing to try it, by affirming to me, that both he and another ſkilful perſon of my acquaintance had like to have been ſpoiled by ſuch attempts: for endeavouring to urge the air beyond a moderate degree of compreſſion, it not only burſt ſome fountains made of glaſs, but when the attempt was made in a large, but thick veſſel, made of ſtrong and compact *Flanders* earth (the ſame with that of jugs and ſtone bottles) the veſſel was, by the over-bent ſpring of the air, burſt with a horrid noiſe, and the pieces thrown off with that violence, that if they had hit him, or his friend, that aſſiſted him in the experiment, they might have maimed him, if not killed him out-right. So that the greateſt unqueſtionable compreſſion of the air ſeems to have been that, recorded in the fifth chapter of our defence againſt the learned *Linus*, where, neverthleſs, we could reduce the air by the weight of a cylinder of mercury of about 100 inches, (which conſequently might near countervail a cylinder of ſixſcore foot of water) but into a little leſs than a fourth part of its uſual extent; but how much further the air may be compreſſed by our new purpoſed way, it is now time to ſhew by the enſuing notes, of which we have not omitted any, that we could find, both that ſome ſcruples, which might elſe ariſe about the way we imployed, may be prevented or ſatisfied; and that the way, we imployed in practiſing this method, might by ſome variety of examples be the better underſtood.

December 13. [4. WE took a large glaſs-egg, with a cylindrical ſtem about the bigneſs of my little finger, and pouring in water, till it reached about a finger's breadth higher than the bottom of the ſtem, we ſet it to freeze in ſnow and ſalt, for ſome hours, with the top of the ſtem (which was drawn out into a very ſlender pipe, almoſt at right angles with the ſtem) open, and there left it for ſome hours, and the water was riſen betwixt ſix and a half, and ſeven inches. This we did in order to another experiment; but then eaſily and nimbly ſealing up the ſlender pipe above-mentioned, that the air in the ſtem might not be heated, we let it continue in the ſnow ſome time, adding freſh for about 24 hours, to obſerve to what degree the water, by expanding itſelf, would compreſs the impriſoned air. The length of the cylinder of the air to be condenſed at the time of the ſealing, was (accounting by eſtimation for the ſlender pipe newly taken notice of) almoſt $9\frac{7}{8}$ inches. This ſpace we obſerved the aſcending water, as the ice increaſed below, to invade by degrees; (for we watched it, and meaſured it from time to time) ſo much, till at length the water reached to 8 inches and $\frac{7}{8}$ almoſt, above the ſtation (which we had carefully marked with a diamond) in which we found it, when the glaſs was ſealed up, leaving but about an inch of air at the top; ſo that of the whole ſpace before poſſeſſed by the air, the water had intruded into near nine parts of ten. Then being partly apprehenſive the glaſs would hold no longer, but have its upper part blown off, as it happened to us a little before with another veſſel, and partly being deſirous to try that which follows, we leiſurely inverted the glaſs, that the air might get up to the ice; for all the water in the ſtem had been purpoſely kept unfrozen: and having provided a jar to receive the water, that ſhould be thrown out, we broke the ſlender pipe, which we had ſealed up, and immediately, as we expected, the compreſſed air, with violence and noiſe, blew out of the ſtem into the jar about ten inches of water; which was ſomewhat more (between half an inch and a whole inch, by reaſon of the ***impetus*** of the ſelf-expanding air) than the ſpace poſſeſſed by the air, before it began to be compreſſed. And beſides this, ſuch a ſtrange multitude of bubbles, that were formerly repreſſed, did now get liberty to aſcend from the lower parts of the glaſs to the top of the remaining water, that it ſomewhat emulated that, which happens to bottled beer, upon the taking out of the cork. *N. B.* when the air was compreſſed beyond ſeven inches, we obſerved divers times, that the inſide of the glaſs poſſeſſed by the air, and neareſt to the water, was round about, to a pretty height, full of very little drops like a ſmall dew; but when we came to break the glaſs, we took no ſuch notice, whether the riſing water had licked them up, or their concourſe made them run down into it, or for ſome other reaſon, we determine not.]

*Another.*

December 13.

[5. We took a ſingle phial filled with water, about half an inch above the lower part of the neck, and leaving about two inches of air in the remaining part of the neck, which was drawn out in a ſlender pipe, like that of the glaſs laſt mentioned, we ſealed it up, the air being firſt well cooled; and expoſing it to freeze, we obſerved a while after, that it had by gueſs condenſed the air into leſſer room. A while after, being in another chamber, we heard a conſiderable noiſe, and imagining what it was, we went directly to the glaſs, whoſe upper part conſiſting of about an inch of the neck, beſides the ſlender pipe, we found had been blown off from the table upon the ground, the body and part of the neck remaining in the ſnow; but this glaſs was of a metal, that uſes to be more brittle than white glaſs.]

*Another.*

[6. A ROUND white glaſs, almoſt filled with water, was ſealed up with care, to avoid heating the included air, which amounted to a cylinder of about 2 inches and $\frac{7}{8}$; after a while the water ſwelled and compreſſed the air almoſt two inches, that is, full two thirds: and then (as we conjectured, becauſe the ſnow reaching too high, froze it in the neck) we found the glaſs cracked in many places of the ball, and the top thrown off at ſome little diſtance from it.]

### *Another.*

[7. A LARGE ſingle phial ſealed, in whoſe neck the air was not condenſed to half its former room, juſt as we were going to break it under water, to obſerve the ſally of the compreſſed air, ſuddenly blew off with a good noiſe, and threw from the table almoſt the whole neck of the phial in one intire piece, which is near four inches long, and at the baſis above an inch broad.]

[8. A GLASS about the bigneſs of a turkey-egg, and of an oval form, with a neck almoſt cylindrical, but ſomewhat wider at the lower than the upper part, was filled with water, till there was left in the neck four inches and a half; whereof the laſt quarter of an inch, and a little more, was much narrower than the reſt, being drawn into a conical ſhape, that it might be eaſily ſealed at the apex; along this cylinder, from the ſurface of the water to the top of the glaſs, was paſted a liſt of paper, divided into inches and quarters: and then the glaſs being carefully and expeditiouſly ſealed up by the flame of a candle, we obſerved, that by holding the glaſs a while in a warm hand, and a room, where there was a good fire, the water was ſwelled up near a quarter of an inch; but placing the glaſs amongſt ſolid pieces of ice mixt with ſalt, the water quickly began to ſubſide upon the infrigidation; and a while after beginning to freeze, it began to ſwell, and by degrees compreſſed the air, till it had crouded it into leſs then a 17th part, by what ſeemed indiſputable; for by eſtimate, it ſeemed to ſome to be crouded into leſs than a 20th part, if not a much leſſer part, of the room it formerly poſſeſſed. Which difference of eſtimates, notwithſtanding the divided paper, proceeded from the change of the figure of the upper end of the glaſs, from the cylindrical, and to ſhew there was no leak at the place where the glaſs was ſealed; beſides that by prying diligently, we could diſcern none; beſides this, I ſay, when the preſſure of the thus crouded air grew too ſtrong for the reſiſtance of the glaſs, it burſt with a noiſe, that made us come to it from ſeveral places of the houſe. The veſſel broke not in the cylindrical part (as I may ſo ſpeak) but in the oval, the whole pipe with the ſealed end remaining entire; the ice appeared full enough of bubbles, which made it white and opacous, and the water, that had aſcended into the neck, upon the breaking was all driven out of it.]

THUS far our collections; but becauſe we had in another glaſs, where the operation was ſooner diſpatched, an opportunity of watching and obſerving ſomewhat more exactly, we will add,

9. THAT the laſt, and poſſibly the beſt experiment we had of compreſſing air by freezing, was made in a ſhort and ſtrong glaſs-egg, whoſe ball was very great in proportion to the ſtem, that the expanding of the water might have the more forcible operation. This veſſel being exactly ſealed, and having a divided liſt of paper paſted along the ſtem, was ſet to freeze with ſnow (or ice) and ſalt, and the contained water did quickly begin to croud the air into a leſſer room, and for a good while aſcended very faſt; till at length it having thruſt the air into ſo ſmall a part of the cavity of the pipe, that we vehemently ſuſpected there might be ſome unheeded flaw or crack of the glaſs, at which the air had ſtolen out, we drew near the veſſel, and attentively prying all about it, to try, if we could diſcover any ground of our ſuſpicion, we found (as far as the divided liſt, and other circumſtances could inform us) that the air (ſuppoſing none of it to have got away) was reduced by our eſtimate into the 19th part of the ſpace it poſſeſſed before. And this our curioſity proved not unſeaſonable; for whilſt we were narrowly ſurveying the glaſs, to ſpy out ſome flaw in it, we were quickly ſatisfied there had been none, by a huge crack made upon the eruption of the included air, whoſe ſpring being, by ſo great a compreſſion, made too ſtrong for

the glaſs to reſiſt, it did with a great noiſe break the ball of the glaſs into many pieces, throwing the unfrozen part of the water upon me, and alſo throwing off the ſtem of the egg, which yet I had the good fortune to recover intire, and which I yet keep by me as a rarity.

10. Thus far we then proceeded in compreſſing the air, which being done in veſſels hermetically ſealed, where no air can get in or out, ſeems to me a more unexceptionable way than thoſe, that have hitherto been thought of. But further, we could not then proſecute it for want both of convenient glaſſes, and of ice or ſnow, of which if we were provided, and particularly of ſtrong glaſſes, we ſhould little doubt of reducing the air to a yet more conſiderable degree of compreſſion.

11. We may add on this occaſion, that we looked upon the ſame way, as ſomewhat leſs unpromiſing than others, that have been hitherto uſed to try the compreſſion of water: for though hitherto neither the experiments of ingenious men, nor thoſe made by our ſelves, have fully ſatisfied us, that water admits any more compreſſion, than it may ſuffer upon the account of the little parcels of air, that are wont to be diſperſed among it; yet the unſucceſsfulneſs may perhaps (for I propoſe it but as a mere conjecture) be imputed to the porouſneſs of the veſſels; wherein, by the ways already practiſed, the experiment muſt be made: whereas in this new way of ours, not only the force, wherewith the compreſſed air preſſes upon the water, grows at length to be exceeding great, and is applied not with a ſudden impetus, as when a pewter veſſel is knocked with a hammer, but by ſlow and regular degrees of increaſe; but the water is kept in a veſſel impervious to its ſubtileſt parts, ſo that it may indeed crack the glaſs, but cannot get out at the pores, as the water compreſſed is wont to do at thoſe of metalline veſſels. The proſecution of this experiment, to bring it to any thing of accurateneſs, we omitted, partly through forgetfulneſs and avocations, and ſometimes for want of conveniency to try it. But by the firſt of the lately mentioned experiments, about the condenſation of air, it ſeems by the ſtrong multitude of bubbles, which upon the breaking of the glaſs appeared in the water, that had been compreſſed betwixt air and the ice, that thoſe two bodies had very violently compreſſed it. And this we are the more apt to believe, becauſe that another time, when we had ſealed up ſome air and water in a glaſs-egg, and permitted the water to ſwell by the operation of the cold, but till it had reduced the air, included with it, to about three quarters of the ſpace it poſſeſt before; even then (I ſay) to try, whether the ſubjacent water were not alſo compreſſed by the air it urged, we broke off the ſealed apex of the glaſs, and perceived, as we expected, the water to aſcend, and that to the height of a quarter of an inch, as we found by meaſure. But ſuch trials having not been, as we juſt now acknowledged, duly proſecuted, we ſhall at preſent content ourſelves to have named this way of attempting the compreſſion of water, without grounding any inferences upon it.

## TITLE XIII.

### *Experiments and obſervations touching the ſphere of activity of cold.*

1. THE ſphere of activity of cold, or, to ſpeak plainer, the ſpace, to whoſe extremities every way the action of a cold body is able to reach, is a thing very well worth the enquiring after, but more difficult to find, than at firſt one would imagine. For to be able to aſſign the determinate limits, within which, and not beyond them, a cold body can operate, ſeveral things are to be taken into conſideration: as firſt, what the degree of cold is, that belongs to the aſſigned body. For it

ſeems rational to conceive, that if a cold body, as ſuch, have a diffuſive virtue, thoſe, that have greater degrees of cold, as ice and ſnow, will be able to diffuſe it to a greater diſtance, as we ſee, that a coal of fire will caſt a ſenſible heat much further than a piece of wood, that is heated without being kindled. Secondly, the medium, through which the diffuſion is made, may help to enlarge the bounds, or ſtraighten the limits of it, as that medium is more or leſs diſpoſed to receive or to tranſmit the action of the cold agent. Thirdly, Not only the conſiſtence, and texture of the medium, but its motion, or reſt, may be conſidered in this caſe. For in froſty and ſnowy weather, men obſerve the winds, that come from frozen lands, to blow more cold, than winds from the ſame quarter would do, in caſe there were no ice nor ſnow in their paſſage. Fourthly, There may be made very differing eſtimates of the diffuſion of cold, according to the inſtrument, that is imployed to receive, and acquaint us with the action of cold. For a liquor or other body may not appear cold to him, that examines it with a weather-glaſs, whilſt he ſhall feel it cold with his hand; and as we elſewhere alſo note, to that ſenſory it ſelf, as it is variouſly diſpoſed, the ſame object will ſeem more or leſs cold; ſo much may the prediſpoſition of the organ impoſe upon the unſkilful or unwary. Fifthly, The very bulk of a cold body may very much inlarge or leſſen its ſphere of activity, as we may have occaſion to ſhew ere long. And beſides, there may be divers other things, that may render it very difficult to aſcertain any thing in this matter. And therefore I ſhall reſerve them for other opportunities, and obſerve now in general, that in ſuch ſmall parcels of ice itſelf, as in our experiments we are wont to deal with, we have found the ſphere of activity of cold exceeding narrow, not only in compariſon of that of heat in fire, but in compariſon of the atmoſphere, if I may ſo call it, of many odorous bodies; as muſk, civet, ſpices, roſes, wormwood, aſſa dulcis, aſſa fœtida, caſtoreum, camphire, and the like; nay, and even in compariſon of the ſphere of activity of the more vigorous load-ſtones: inſomuch that we have doubted, whether the ſenſe could diſcern a cold body, otherwiſe than by immediate contact.

2. AND to examine this, having taken a piece of ice, we did not find upon trials, that I partly made my ſelf, and partly cauſed in my preſence to be made by others, that if a man's eyes were cloſe ſhut, he could certainly diſcern the approach of a moderately-ſized piece of ice, though held never ſo near his fingers ends. Nay, which is more conſiderable, having had the curioſity to make the trial, with one of thoſe very ſenſible thermoſcopes I have formerly mentioned (wherein a pendulous drop of liquor plays up and down in a ſlender pipe) I found, that by holding it very near to little maſſes of ſnow (ſomewhat compacted too) the moveable drop did not betray any manifeſt operation of ſo cold a neighbouring body; but if the glaſs were made to touch the ſnow, the effect would then be notable, by the haſty deſcent of the pendulous drop, or its motion towards the obtuſe part of the inſtrument, in caſe that were not perpendicularly, but laterally applied to the ſnowy lumps. But this languidneſs of operation may perhaps proceed in great part from the ſmallneſs of the pieces of ice, that were imployed; for hearing of a merchant, that had made divers obſervations about cold in *Greenland*, I deſired, by the mediation of a very learned friend, to be informed, whether or no in the night they could perceive thoſe vaſt heaps, or rather mountains of ice, that are wont to float up and down in that ſea, by any new and manifeſt acceſſion of cold, and was informed by way of anſwer to that queſtion, that being at ſea, they could know the approach of ice, as well by the increaſe of cold, as by the glaring light which the air ſeemed to receive from the neighbouring ice.

3. But that, which makes me ſuſpect, that there may in this account be ſome miſtake, is, that I have not yet met with any like obſervation in any of the voyages into gelid climates, that I have had occaſion to peruſe, though in ſome of them the navigators frequently mention their having met with vaſt rands (as ſome call them) and iſlands of mountainous ice in the night. And it is, as I remember, the complaint of one or two, if not more of them, that the ſhip lay cloſe by ſuch vaſt pieces of ice, without their being aware of it, by reaſon of the fogs. By which it ſeems, that there was no ſenſible cold diffuſed to any conſiderable diſtance, whereby they might be advertiſed of the unwelcome neighbourhood even of ſo much ice, but poſſibly the approach of far ſmaller maſſes of ice would have been ſenſible to them in ſuch a climate as ours, where the organs would not have been indiſpoſed to feel, by a long accuſtomance, any thing of near ſo intenſe a degree of cold, as that which then reigned in thoſe northern ſeas.

4. Whilst we were conſidering the difference betwixt the operations of even the coldeſt bodies at the very neareſt diſtance, and upon immediate contact, we thought it an experiment not altogether unworthy to be tried, whether, though ice and ſnow alone, that is, unaſſiſted by ſalts, would not in ſome of our formerly mentioned experiments freeze water, through the thickneſs even of a thin glaſs, they may not yet do it when the water is immediately contiguous to them. And I remember, that we took a conveniently ſhaped glaſs, and having frozen the contained water for ſome hours, from the bottom upwards, till the ice was grown to be of a conſiderable thickneſs, we marked what part of the glaſs was poſſeſſed by the unfrozen water; and then removing the veſſel to a little diſtance from the ſnow, and ſalt, it ſtood in before, we let it reſt there, to try whether the ice would freeze any part of the contiguous and incumbent water; but ſome intervening accidents hindred us from being able to derive any great ſatisfaction one way or other from our trial.

5. Wherefore we ſhall add, by way of compenſation, that the diligent *Olearius* relates, that at *Iſpahan*, the capital city of *Perſia*, though it be ſeated in a very hot climate, and though it ſeldom freeze there above a finger thick, and the ice melt preſently at ſun-riſing, yet the inhabitants have conſervatories, which they furniſh with ſolid pieces of ice of a good thickneſs, only by pouring at night great ſtore of water, at convenient intervals of time, upon a ſhelving floor of free-ſtone or marble; whereon, as the water runs over it, the moſt diſpoſed of its parts are in their paſſage arreſted, and frozen by the contiguous ice, which by this means (ſays my learned author) may be brought in two or three ſucceſſive nights to a very conſiderable thickneſs.

Voyage de Moſcovie & de Perſe, Liv. V.

6. We ſeveral times gave order to have this experiment tried in *England*; but *partly* through the negligence of thoſe we employed, and *partly* upon the ſcore of intervening circumſtances, our expectation was but ill anſwered. And in this caſe I mention *intervening circumſtances*, becauſe having cauſed a ſervant to pump in the night, upon a not very thin plate of ice, that was laid ſhelving upon a board, and another flat piece of ice being about the ſame time laid under a place, where water derived from a neighbouring ſpring is wont continually to drop, he brought me word, that not only in this laſt named place, the ice melted away, but that under the pump, inſtead of increaſing in thickneſs by the waters running over it, it was thereby rather diſſolved. At which ſomewhat wondering, I went in the morning myſelf to the pump, and cauſing a good piece of ice to be in a convenient poſture placed under it, I obſerved the water, as it came out of the pump, and was falling on the ice, to ſmoak, as if the depth of the well had made the water, though very cold to the

touch, ſomewhat warm in compariſon of the ice, and thereby fitter to diſſolve than to increaſe it; (which inconvenience may be prevented by ſuffering the water of deep ſprings and wells to ſtand to cool in the air, before it be put to the ice) and this, though the neighbouring air were, as I found by manifeſt proofs, ſo cold, that I was not tempted to impute the unſucceſsfulneſs of the experiment, rather to its want of a ſufficient coldneſs, than the water's. So that till I have an opportunity of making a further trial, I cannot ſay more to the *Perſian* way of augmenting ice. But to proceed: Our having met with but an unſatisfactory account of this experiment, which we were the more troubled at, becauſe this ſeemed a promiſing way of trying that, which otherwiſe is not ſo eaſily reduced to experiment; for the temperature of the air muſt be ſeriouſly conſidered in aſſigning the cauſe of divers trials, that may be made for the reſolving of the ſame queſtion: For to omit other examples, here in *England* we find, that water poured on ſnow is wont to haſten the diſſolution of it, and not to be congealed by it; whereas having inquired of an ingenious perſon, that lived a good while among the *Ruſſians*, he informed me, that it was their uſual way to turn water and ſnow into ice, by pouring a convenient proportion of that liquor into a great quantity of ſnow: and having alſo inquired, whether ice had not the like operation, he told me, that it was uſual, and he had ſeen it practiſed in *Muſcovy*, to cement ice to buildings, and other things, and alſo to caſe over bodies, as it were, with ice, by gradually throwing water upon them. But I doubt, whether that effect be to be aſcribed barely to the contiguity of ice, becauſe I learned of him, that this way of increaſing ice is practiſed in very froſty weather, when water thinly ſpread upon almoſt any other body would be frozen by the vehement ſharpneſs of the air.

7. THE glaciations, that nature unguarded by art is wont to make, beginning at thoſe parts of bodies, at which they are expoſed to the air; it uſually happens, that they freeze from the upper towards the lower parts. But how far in earth and water (the moſt conſiderable bodies, that are ſubject to be frozen) the froſt will pierce downwards, though, for ſome hints it would afford, worth the knowing, is not eaſy to be defined; becauſe the deepneſs of the froſt may be much varied by the degree of coldneſs in the air, by which the glaciation ſeems to be produced, as alſo by the greater or leſſer duration of the froſt, by the looſer or cloſer texture of the earth, by the nature of the juices, wherewith the earth is imbued, and by the conſtitution of the ſubjacent and more internal parts of the earth, ſome of which ſend up either actually warm, or potentially hot and reſolving ſteams, ſuch as thoſe, that make corroſive liquors in the bowels of the earth; ſo that the froſt will not ſeize upon, or at leaſt cannot continue over mines. And I have ſeen good large ſcopes of land, where vaſt quantities of good lime-ſtone lay near the ſurface of the earth, on which I have been aſſured by the inhabitants, that the ſnow will not lie. There are divers other things, that may vary the depth, to which the froſt can penetrate into the ground, (I ſay, into the ground, becauſe in moſt caſes it will pierce deep into the water) but yet, that we may not leave this part of the *Hiſtory of Cold* altogether uncontributed to, we will add ſome of our notes, whereby it will appear that in our climate the froſt pierces far leſs into the ground, than many are pleaſed to think.

8. THE notes I find about this matter are theſe that follow, which I tranſcribed unaltered, becauſe it were tedious, and not worth while to add the way we imployed, and the cautions we uſed in making the obſervations; but we ſhall rather intimate, that the following trials were made in a village about two miles from a great city.

[I. AFTER

Jan. 22. [I. After four nights of froſt, that was taken notice of for very hard, we went into an orchard, where the ground was level, and not covered with graſs, and found by digging, that the froſt had ſcarce pierced into the ground three inches and a half. And in a garden nearer the houſe, we found not the earth to be frozen more than two inches beneath its ſurface.

II. Nine or ten nights ſucceſſive froſt froze the graſsleſs ground in the garden, about ſix inches and a half, or better in depth, and the graſsleſs ground in the orchard, where a wall ſheltered it from the ſouth ſun, to the depth of about eight inches and a half, or better.]

Feb. 9. [We digged in an orchard near a wall, that reſpects the north, and found the froſt to have pierced the ground about a foot and two inches, at leaſt above a foot: this is the eighth day ſince it was about eight inches and a half.]

[A slender pipe of glaſs, about 18 inches long, and ſealed at one end, was thruſt over night into a hole, purpoſely made with a ſpit ſtraight down into the ground, the ſurface of the water being in the ſame level with that of the earth; the next morning the tube being taken out, the water appeared frozen in the whole capacity of the cylinder, but a little more than three inches. But from this ſtick of ice, there reached downwards a part of a cylinder of ice of about ſix inches in length, the reſt of the water remained unfrozen, though it were an exceeding ſharp night, preceded by a conſtitution of the air, that had been very laſting, and very bitter. The earth in the garden, where this trial was made, we gueſſed to be frozen eight or ten inches deep, as it was in another place about the ſame houſe. But, if this tube had not been in the ground, the ambient air would have frozen it quite through.]

9. Another note much of the ſame import, we find in another place of our collections.

Finding, that by reaſon of the mildneſs of our climate, I was ſcarce to hope for any much deeper congelation of the earth or water, I applied myſelf to inquire of an ingenious man, that had been at *Moſco*, whether he had obſerved any thing there to my preſent purpoſe, as alſo to find in captain *James*'s voyage, whether that inquiſitive navigator had taken notice of any thing, that might inform me, how far the cold was able to freeze the earth or water in the iſland of *Charleton*, where that quality may probably be ſuppoſed to have had as large a ſphere of activity, as in almoſt any part of the habitable world. And by my inquiries I found, that even in frozen regions themſelves, a congealing degree of cold pierces nothing near ſo deep into the earth or ſea as one would imagine; for the traveller I ſpoke with, told me, that in a garden in *Moſco*, where he took notice of the thing I inquired about, he found not the ground to be frozen much above two foot deep. And in captain *James*'s journal, *page* 63. the moſt that I find (and that too, where he gives an account of the prodigiouſly tall ice they had in *January*) concerning the piercing of the froſt into the ground, is this, that *the ground at ten foot deep was frozen* Whence by the way we may gather how much ſharper cold may be preſumed to have reigned in that iſland, than even in *Ruſſia*. And as for the freezing of the water, he does in another place occaſionally give us this memorable account of it, where he relates the manner of the breaking up the ice in the frozen ſea, that ſurrounds the iſland we have been ſpeaking of: 'It is firſt to be noted (ſays he, *page* 86.) that it doth not freeze (naturally) 'above ſix foot; the reſt is by accident; ſuch is that ice, that you may ſee here ſix 'fathom thick. This we had manifeſt proof of, by our digging the ice out of the 'ſhip, and by digging to our anchors before the ice broke up.' The reſt of that account not concerning our preſent purpoſe, I forbear to annex; only

taking

touch, ſomewhat warm in compariſon of the ice, and thereby fitter to diſſolve than to increaſe it; (which inconvenience may be prevented by ſuffering the water of deep ſprings and wells to ſtand to cool in the air, before it be put to the ice) and this, though the neighbouring air were, as I found by manifeſt proofs, ſo cold, that I was not tempted to impute the unſucceſsfulneſs of the experiment, rather to its want of a ſufficient coldneſs, than the water's. So that till I have an opportunity of making a further trial, I cannot ſay more to the *Perſian* way of augmenting ice. But to proceed: Our having met with but an unſatisfactory account of this experiment, which we were the more troubled at, becauſe this ſeemed a promiſing way of trying that, which otherwiſe is not ſo eaſily reduced to experiment; for the temperature of the air muſt be ſeriouſly conſidered in aſſigning the cauſe of divers trials, that may be made for the reſolving of the ſame queſtion: For to omit other examples, here in *England* we find, that water poured on ſnow is wont to haſten the diſſolution of it, and not to be congealed by it; whereas having inquired of an ingenious perſon, that lived a good while among the *Ruſſians*, he informed me, that it was their uſual way to turn water and ſnow into ice, by pouring a convenient proportion of that liquor into a great quantity of ſnow: and having alſo inquired, whether ice had not the like operation, he told me, that it was uſual, and he had ſeen it practiſed in *Muſcovy*, to cement ice to buildings, and other things, and alſo to caſe over bodies, as it were, with ice, by gradually throwing water upon them. But I doubt, whether that effect be to be aſcribed barely to the contiguity of ice, becauſe I learned of him, that this way of increaſing ice is practiſed in very froſty weather, when water thinly ſpread upon almoſt any other body would be frozen by the vehement ſharpneſs of the air.

7. THE glaciations, that nature unguarded by art is wont to make, beginning at thoſe parts of bodies, at which they are expoſed to the air; it uſually happens, that they freeze from the upper towards the lower parts. But how far in earth and water (the moſt conſiderable bodies, that are ſubject to be frozen) the froſt will pierce downwards, though, for ſome hints it would afford, worth the knowing, is not eaſy to be defined; becauſe the deepneſs of the froſt may be much varied by the degree of coldneſs in the air, by which the glaciation ſeems to be produced, as alſo by the greater or leſſer duration of the froſt, by the looſer or cloſer texture of the earth, by the nature of the juices, wherewith the earth is imbued, and by the conſtitution of the ſubjacent and more internal parts of the earth, ſome of which ſend up either actually warm, or potentially hot and reſolving ſteams, ſuch as thoſe, that make corroſive liquors in the bowels of the earth; ſo that the froſt will not ſeize upon, or at leaſt cannot continue over mines. And I have ſeen good large ſcopes of land, where vaſt quantities of good lime-ſtone lay near the ſurface of the earth, on which I have been aſſured by the inhabitants, that the ſnow will not lie. There are divers other things, that may vary the depth, to which the froſt can penetrate into the ground, (I ſay, into the ground, becauſe in moſt caſes it will pierce deep into the water) but yet, that we may not leave this part of the *Hiſtory of Cold* altogether uncontributed to, we will add ſome of our notes, whereby it will appear that in our climate the froſt pierces far leſs into the ground, than many are pleaſed to think.

8. THE notes I find about this matter are theſe that follow, which I tranſcribed unaltered, becauſe it were tedious, and not worth while to add the way we imployed, and the cautions we uſed in making the obſervations; but we ſhall rather intimate, that the following trials were made in a village about two miles from a great city.

[I. After four nights of froſt, that was taken notice of for very hard, we went into an orchard, where the ground was level, and not covered with graſs, and found by digging, that the froſt had ſcarce pierced into the ground three inches and a half. And in a garden nearer the houſe, we found not the earth to be frozen more than two inches beneath its ſurface. Jan. 22.

II. Nine or ten nights ſucceſſive froſt froze the graſsleſs ground in the garden, about ſix inches and a half, or better in depth, and the graſsleſs ground in the orchard, where a wall ſheltered it from the ſouth ſun, to the depth of about eight inches and a half, or better.]

[We digged in an orchard near a wall, that reſpects the north, and found the froſt to have pierced the ground about a foot and two inches, at leaſt above a foot: this is the eighth day ſince it was about eight inches and a half.] Feb. 9.

[A slender pipe of glaſs, about 18 inches long, and ſealed at one end, was thruſt over night into a hole, purpoſely made with a ſpit ſtraight down into the ground, the ſurface of the water being in the ſame level with that of the earth; the next morning the tube being taken out, the water appeared frozen in the whole capacity of the cylinder, but a little more than three inches. But from this ſtick of ice, there reached downwards a part of a cylinder of ice of about ſix inches in length, the reſt of the water remained unfrozen, though it were an exceeding ſharp night, preceded by a conſtitution of the air, that had been very laſting, and very bitter. The earth in the garden, where this trial was made, we gueſſed to be frozen eight or ten inches deep, as it was in another place about the ſame houſe. But, if this tube had not been in the ground, the ambient air would have frozen it quite through.]

9. Another note much of the ſame import, we find in another place of our collections.

Finding, that by reaſon of the mildneſs of our climate, I was ſcarce to hope for any much deeper congelation of the earth or water, I applied myſelf to inquire of an ingenious man, that had been at *Moſco*, whether he had obſerved any thing there to my preſent purpoſe, as alſo to find in captain *James*'s voyage, whether that inquiſitive navigator had taken notice of any thing, that might inform me, how far the cold was able to freeze the earth or water in the iſland of *Charleton*, where that quality may probably be ſuppoſed to have had as large a ſphere of activity, as in almoſt any part of the habitable world. And by my inquiries I found, that even in frozen regions themſelves, a congealing degree of cold pierces nothing near ſo deep into the earth or ſea as one would imagine; for the traveller I ſpoke with, told me, that in a garden in *Moſco*, where he took notice of the thing I inquired about, he found not the ground to be frozen much above two foot deep. And in captain *James*'s journal, *page* 63. the moſt that I find (and that too, where he gives an account of the prodigiouſly tall ice they had in *January*) concerning the piercing of the froſt into the ground, is this, that *the ground at ten foot deep was frozen* Whence by the way we may gather how much ſharper cold may be preſumed to have reigned in that iſland, than even in *Ruſſia*. And as for the freezing of the water, he does in another place occaſionally give us this memorable account of it, where he relates the manner of the breaking up the ice in the frozen ſea, that ſurrounds the iſland we have been ſpeaking of: ‘ It is firſt to be noted (ſays he, *page* 86.) that it doth not freeze (naturally) ‘ above ſix foot; the reſt is by accident; ſuch is that ice, that you may ſee here ſix ‘ fathom thick. This we had manifeſt proof of, by our digging the ice out of the ‘ ſhip, and by digging to our anchors before the ice broke up.’ The reſt of that account not concerning our preſent purpoſe, I forbear to annex; only taking notice, that notwithſtanding our lately mentioned experiment of freezing water in a glaſs tube thruſt into the ground, yet it ſeems, that at leaſt where captain *James* wintered, the water was not much above half ſo thick frozen as the earth. But we have already noted the indiſpoſition of ſalt water to congelation; and whether freſh water would not have been deeper frozen, may be juſtly doubted.

## TITLE XIV.

### *Experiments touching the differing Mediums, through which cold may be diffuſed.*

1. IN examining whether cold might be diffuſed through all mediums indefinitely, notwithſtanding their compactneſs, or the cloſeneſs of their texture, we muſt have a care not to make our trials with mediums of too great thickneſs, leſt we miſtakingly impute that to the nature of the medium, which is indeed cauſed by the diſtance, which the medium puts betwixt the agent and the patient. For the mixtures of ice and ſnow, wherewith we made our experiment, will operate but at a very ſmall diſtance, though the medium reſiſt no more than the common air, as may appear by ſome of the experiments recorded in this treatiſe.

THIS premiſed, we may proceed to relate, that having placed a copious mixture of ice and ſalt in pipkins glazed within, and in white baſons glazed both within and without, we obſerved, that the outſide of both thoſe ſorts of veſſels was cruſted over with ice: though, however the baked earth had not been compact, nor the vitrified ſurface of a very cloſe texture; the very thickneſs of the veſſels was ſo great, that it ſeemed it would ſcarce have been able to freeze at a greater diſtance.

2. BY the experiments formerly mentioned of freezing water in pewter bottles, it appears, that cold is able to operate through ſuch metalline veſſels.

3. AND this may be ſomewhat confirmed by one of the pretrieſt experiments, that is to be performed by the help of cold, namely, the making icy cups to drink in. The way we uſed was this; we cauſed to be made a cup of lattin (by which I mean iron reduced into tin plates, and tinned over on both ſides) of the ſhape and bigneſs I intended to have the cup of; then I cauſed to be made of the ſame matter another cup of the ſame ſhape with the former, but every way leſs; ſo that it would go into the greater, and leave a competent interval for water betwixt its convex ſurface, and the concave of the other. This innermoſt cup was furniſhed with a rim or lip, by which it leaned upon the greater, and by whoſe help its ſides and bottom were eaſily placed at a juſt and even diſtance from the ſides and bottom of the other; but the diſtance between the two bottoms is made greater, than that between the ſides, that the icy cup might ſtand the firmer, and laſt the longer. The interval between the two parts of this mould being filled with water, and the cavity of the internal cup being filled with a mixture of ice and ſalt, (partly to freeze the contiguous water, and thereby cooperate to the quicker making of the cup, and partly by its weight to keep the water from buoying up ſo light a cup) the external part was ſurrounded with ice and ſalt, whoſe cold ſo powerfully penetrated to the internal metalline mould, that the water was quickly frozen, and (the parts of the mould being disjoined) appeared turned into an icy cup of the bigneſs and figure deſigned. And theſe cups being eaſily to be made, and of various ſhapes (and that in the midſt of ſummer, if ſnow or ice be at hand) are very pleaſant trifles, eſpecially in hot weather, when they impart a very refreſhing coolneſs to the drink poured into them; and though they laſt not long, eſpecially if they be employed to drink wine, and ſuch like ſpirituous drinks in, yet whilſt ſome are melting, others may be provided, and ſo the loſs may

be eaſily repaired. All the difficulty we met with, was to disjoin the parts of the mould, which are wont to ſtick very faſt to the ice they include: and we tried to obviate this, ſometimes by anointing the inſide of the mould with ſome unctuous and not offenſive matter, to hinder the adheſion of the ice, and ſometimes by applying ſome convenient heat both to the convex part of the external, and the concave part of the internal piece of the mould; which laſt mentioned way is quick and ſure, but leſſens the durableneſs of the cup.

[We were lately informed, that this way of making cups of ice, is ſet down in *Barcley's Argenis*, and it is like enough, that ingenious man may have learned it amongſt ſome of the virtuoſi of *Italy* he converſed with: but if we, that learned it from none of them, had not been taught it by experience, we ſhould ſcarce have ventured to try it upon the credit of a romance; that ſort of compoſures being wont to be fabulous enough to paſs but for poems in proſe.]

4. The learned and induſtrious mathematician *Eraſmus Bartholinus* mentions in his newly-publiſhed diſcourſe *de Figurâ Nivis*, an experiment, by which he tells us, that ſome maſters of nature's ſecrets do eaſily, even in the midſt of heat, reduce air into water. For they put a little ſnow or ice into a funnel, and thereby ſo refrigerate and condenſe the ambient air, that there will dew trickle down the ſides of the funnel: by which means it has been ſaid, that ſome ingenious men have hoped to make an artificial fountain in the midſt of ſummer. But I here mention this experiment rather, becauſe it is not unlikely to pleaſe thoſe, to whom it is new, and becauſe having purpoſely tried in large and thick funnels of glaſs, it may be pertinently enough delivered in this place, (where we are treating of the tranſmiſſion or propagation of cold through cloſe and thick mediums) than becauſe we expect to make of it that uſe, eſpecially that œconomical uſe, that has been lately intimated. For firſt, it will be very hard to prove, that it is the very air itſelf, and not rather the vapours ſwimming in it, that are by this means tranſmuted into water. And ſecondly, it is true indeed, that a mixture of ſnow and ſalt will condenſe vapours on the outſide of a funnel; but either they, that hoped to make this uſe of the experiment, have little experience of it, and write conjecturally, or elſe they have made it with a ſucceſs very differing from ours. For though we employed a large funnel, and ſuſpended it by a ſtring (artificially enough tied about it) in the free air; and though the mixture of ice and ſalt we put in, were ſufficiently infrigidating (as will appear by and by) and far more ſo, than ice or ſnow alone would have been; yet that mixture being not able to condenſe the vaporous parts of the air into dew, much, if at all, longer than the mutual diſſolution of the ſalt and ſnow laſted, the liquor, that was this way obtained, and dropped down at the bottom of the funnel (whoſe internal perforation ought to be carefully ſtopped, leſt any of the reſolved ſnow and ſalt ſhould fall through, and ſpoil the other liquor) was indeed ſweet like rain-water, but ſo very little, as well as ſo ſlowly generated, that it amounted not any thing near to that, which the ſnow imployed, and ſpoiled to make it, would have afforded. So that it may be queſtioned, whether ſome cooling liquors, which can as well as this mixture condenſe the vapid air into water, and whoſe texture is not deſtroyed in this operation, as that of the ſnow is, might not be more hopefully imployed to obtain water from the air; to which I ſhall only add this one thing, that the mixture of ſnow and ſalt did turn the vapours, that faſten themſelves to the outſide of the glaſs, firſt into ice, before they drop down in the form of water, in almoſt all our trials of this nature, as well in thick funnels, as in other, and thinner glaſſes.

5. That in hermetically ſealed glaſſes, an included mixture of ſnow and ſalt will freeze the vapours of the air on the outſide of the glaſs, divers of the experiments of

the preſent treatiſe do manifeſtly evince; which argue, that even ſo extremely cloſe a medium as glaſſes is not able to hinder the tranſmiſſion of cold. And this is not ſuperfluouſly added, becauſe in veſſels not hermetically ſealed, it may be pretended, that it is the internal air, that communicates its coldneſs by ſome unheeded, but immediate intercourſe, with the external.

AFTER this we thought it worth an experiment, to try, whether, or how, cold would be diffuſed through a medium, that ſome would think a vacuum, and which to others would ſeem much leſs diſpoſed to aſſiſt the diffuſion of cold, than common air itſelf. To compaſs this, the expedient we bethought ourſelves of, was to ſuſpend a ſlender glaſs full of water in one of the ſmall receivers belonging to our pneumatical engine; and when the air was very carefully pumped out, to bury the exhauſted receiver in a copious and ready prepared mixture of ice and ſalt, to ſee whether, notwithſtanding the withdrawing of the medium, the water ſuſpended in a kind of vacuum, as to air or groſs ſubſtances, would yet be frozen by the cold. That event of our trials, which alone I find among my notes, is regiſtered in theſe terms.

6. [A SMALL pipe, ſealed at one end, was, at the other, filled almoſt with water, and was put into a receiver, conſiſting of a ſomewhat long and ſlender tube of glaſs, ſealed at one end, and inverted upon the engine plate; then the air was carefully exhauſted, and the pump was plied; a while after no air appeared to come forth in any bubble out of the receiver, through the external water: nor did the water in the ſmall pipe within diſcloſe any number of bubbles worth taking notice of: then by the help of an almoſt cylindrical plate of iron, beaten ice and ſalt were heaped againſt the outſide of the receiver, about the height, to which the water in the ſmall pipe reached. And at length, though, as we all thought, much more ſlowly than ſuch a congelation would elſe have been performed, the water was for the moſt part frozen in odd kind of flakes from the top to the bottom, and the ice ſeemed not to have any conſiderable number of bubbles.]

7. THERE is one experiment, I have made about the tranſmiſſion of cold through indiſpoſed mediums, which may not be unworthy to be here inſerted. For I had once a mind to try, whether a cold body could operate through a medium, that was, as to touch, actually hot, and had its heat continually renewed by a fountain, as it were, of heat, that perpetually diffuſed through it new ſupplies of warm liquor; ſo that the cold body could not here, as in other caſes, firſt allay the heat of the medium, and then leſſen it more and more, till it had quite extinguiſhed it. To compaſs this, I had ſoon after an opportunity of making ſome trials preſented me: for being at the mineral ſprings at *Tunbridge*, to drink thoſe wholeſome waters for my health's ſake, I ſoon accuſtomed myſelf to drink them in conſiderable quantities very early in the morning, when they were exceeding cold, and ſometimes drinking them in bed, as well as ſometimes at the ſpring's head, I had the curioſity to obſerve, whether, in caſe I took them down very faſt, they would not through the warm muſcles and outward parts of the abdomen, diffuſe a ſenſible coldneſs: and upon more trials than one, I found, that by laying my warm hands on the outſide of my belly, I there felt, at leaſt as it ſeemed to me, a manifeſt and conſiderable degree of coldneſs. And when I related this to ſome ingenious perſons, that were better acquainted with thoſe ſprings than I, they told me, that there was among thoſe many, that then reſorted to thoſe famous ſprings, a knight, whoſe name I remember not, whoſe diſeaſe being judged formidable, the phyſicians enjoined him to drink in a morning two or three times the quantity, that afforded me the obſervation I was relating; and that when this knight had filled his belly with ſo much water, he uſed

mightily to complain of the coldneſs it diffuſed through his abdomen, inſomuch that he was fain to ply thoſe parts long with hot napkins clapped to them, one after another; which yet, as he complained, were ſoon refrigerated by the exceſſive cold, that the water diffuſed to the outſide of his belly; which yet nevertheleſs was not, that I could learn, at all prejudiced, no more than mine, by ſo ſenſible and piercing a cold.

8. It may be doubted, whether in caſe water be not fluid upon the account of a congenite motion in the corpuſcles it conſiſts of, its fluidneſs may not proceed from the agitation of the ambient air, either immediately contiguous to the ſurface, or communicating its agitation to the water, by propagation of its impulſe, through the veſſel, that interpoſes betwixt them. To contribute to the clearing of this, and ſome other things, we deviſed the following experiment: We provided a glaſs-bubble, of about the bigneſs of a walnut, and the form almoſt of a pear, whoſe ſtem was purpoſely made crooked for the conveniency of ſuſpenſion. This being filled with water (which is troubleſome enough to be done, unleſs one have the knack) we hung it at one end of a thread, whoſe other end we paſt through a cork, by a perforation purpoſely made; into which we afterwards faſtened a thread, by thruſting in a ſmall peg to rivet it in. Then filling a glaſs not very broad, but yet furniſhed with a mouth wide enough to receive the bubble, with oil of turpentine, ſuch as we bought it at the ſhops, we ſtopped the orifice with the newly mentioned cork; ſo that the ſealed bubble hanging as it was covered, and every way ſurrounded by the oil of turpentine; which being a liquor, that (at leaſt in ſome colds as we here have) will not freeze, we placed the glaſs in beaten ice and ſalt, and as it were buried it therein: and at the end of about three hours (having been diverted by ſome occaſions from taking it ſooner out) we found, as we had conjectured, that, notwithſtanding that, the oil of turpentine, continued perfectly fluid as before, yet the bubble totally immerſed in this heating chymical oil was frozen throughout, not excepting that, which was harboured in the little neck or ſtalk; and when I came to lift it out of the liquor, the glaſs being cracked (as we ſuppoſed by the cold) the ſtring brought up a little part of that, which was neareſt to it; the reſt in the form above-mentioned ſtaying behind and ſubſiding. And that, which was remarkable in this piece of ice, was, that when we had taken it out, it appeared cleft very deep (from the outſide almoſt to the centre) according to a line drawn from the ſlendereſt part of it, almoſt as if one ſhould with a knife cut a pear in two, from the ſtalk downwards, according to its whole length. And theſe two pieces were eaſily enough ſeparable, and (to add that circumſtance) for trial ſake we left them divided in the ſame liquor and veſſel, with ſome thawing ice and ſalt about them, for 14 or 15 hours, without finding them any thing near ſo much waſted or reſolved into water, as moſt would have expected.

Whilst the above-mentioned veſſel was expoſed to be frozen, we likewiſe placed by it another veſſel, a glaſs-egg, whoſe ball and a little part of its ſtem we had filled with ſome of the very ſame parcel of oil of turpentine; and placing about the ſides of the egg ſome ice and ſalt, we obſerved, as we expected, that the liquor was, after a little while, made by the cold to ſubſide about half an inch: ſo that it is worth ſome philoſophers conſidering, why, if according to the lately mentioned atomical doctrine, cold be made by the introduction of ſwarms of real and extended, though atomical bodies, they ſhould pervade the oil, and contract it without freezing it, but freeze the water without contracting it, but expanding it rather.

9. [A small bubble of the bigneſs of a very little nutmeg, filled with water, and hermetically ſealed up, was by a cork and a ſtring ſuſpended in ſpirit of wine, ſo as to be ſurrounded therewith; and being expoſed to the air the ſame night, in the ſtopt

glaſs, was the next morning found altogether frozen, though the ſpirit of wine it ſelf were not at all ſo: but another bubble, by the help of a ſtring cork, and piece of lead, carefully ſuſpended in a ſtrong ſolution of ſea-ſalt, and expoſed at the ſame time in a like veſſel with the former, when they both came to be looked upon, appeared to be no more frozen than the brine it ſelf, which was not ſo at all.]

10. [A GLASS bubble of the bigneſs of a ſmall nutmeg, filled with water, and hermetically ſealed, being immerſed by a weight of lead faſtened to it, beneath the ſurface of a very ſalt brine, but yet not ſo as to reach the bottom of the liquor or glaſs, was expoſed all night to freeze, in weather, that was extraordinarily cold; but neither the impriſoned water, nor the other appeared to be at all frozen. The like experiment we repeated another froſty night, but without freezing either of the liquors. But to ſhew the uſefulneſs of repeating experiments about cold, if there be opportunity, and eſpecially in ſuch caſes, where the degree or ſome other circumſtance may much vary the event, we will add, that having expoſed a bubble like that newly mentioned, and immerſed in ſpirit of wine, we found the next morning the water in the bubble turned into ice; and having likewiſe expoſed ſuch a bubble immerſed in very ſtrong brine, to be frozen by a mixture of ice and ſalt, within about two hours after, we found the bubble broken, as we ſuppoſed, upon the expanſion of the water upon its growing ice. And we alſo found the upper part of the bubble with the ice ſticking to it, and the other part of the glaſs was cracked, with lines running from a point almoſt like the pole and meridian in a globe; whence we concluded the glaſs to have been, as it is probable, burſt aſunder upon the expanſion of the freſh water into ice; and that the reaſon, why there remained but a comparatively little parcel of ice, was probably, that the ſalt water getting in at thoſe crannies or chinks, diſſolved as much of the new-made ice, as in a little while it could eaſily reach.

*Beſides*;

11. [WE filled a glaſs bubble with fair water, and having hermetically ſealed it, we ſuſpended it by a ſtring faſtened to the cork in the cavity of a wide-mouthed glaſs well ſtopt, ſo that the bubble was every way at a good diſtance from the ſides, bottom, and top of the glaſs. This we did to try, whether a ſufficient degree of cold at that diſtance would be freely tranſmitted through the glaſs, without the intervention of a viſible liquor; and accordingly we found the ſuſpended bubble cracked by the ice, that filled it.]

## TITLE XV.

### *Experiments and obſervations touching ice.*

1. A GREAT part of our preſent hiſtory being imployed about delivering the phænomena of congelation, it is not to be expected, that in this ſection, where we treat of ice as a diſtinct part of our theme, we ſhould deliver all thoſe particulars, that have occurred to us, wherein ice is concerned. And therefore we ſhall reſtrain our ſelves to the mention of thoſe, that belong to ice, conſidered, as it conſiſts of intire and diſtinct portions of congealed water. And though we ſhall deliver ſome few experiments of our own, ſuch as we had any opportunity to make, yet much the greater part of this ſection will fitly enough be taken up by collections out of travellers, and navigators, into thoſe colder regions, that afford much conſiderabler, or at leaſt much ſtranger obſervations concerning ice, than are to be met with in ſo temperate a climate as ours. And what we have to deliver in this ſection will naturally be divided into two parts, the one conſiſting of our own experiments, and

the other containing ſome paſſages, that we have ſelected out of voyages, or that have been afforded us by the relations of credible travellers. And of theſe two ſorts of obſervables, that, which has been firſt mentioned, ſhall be firſt treated of.

2. Some, that have been in the *Eaſt-Indies*, inform us, that in ſome parts of thoſe countries they were looked upon as great liars, for affirming, that in *Europe* the fluid body of water was often without any artifice or endeavour of man turned in a few hours into a ſolid and compact body, ſuch as ice. And certainly, if cuſtom did not take away the ſtrangeneſs of it, it would to us alſo appear very wonderful, that ſo great a change of texture ſhould be ſo eaſily and inartificially produced. But how ſolid the body of ice is, or rather how ſtrong is the mutual adheſion of its parts, has not yet, that we know of, been attempted by experiments to be reduced to ſome kind of eſtimate: and indeed ſo many things muſt be taken into conſideration, that it will be difficult to arrive at any more than a fair conjecture in this matter; eſpecially, becauſe (I think) it may juſtly be doubted, whether or no differing degrees of cold may not vary the degree of compactneſs of the ice. And my doubt will not perhaps appear groundleſs, if I add, that having, to ſatisfy my ſelf, inquired of an intelligent perſon, that lived ſome years in *Ruſſia*, he anſwered me, that he found the ice of thoſe parts to be much harder than that of theſe.

3. We had in our thoughts divers ways to eſtimate the coheſion of the parts of ice, whereof one was, to freeze water in a hollow metalline cylinder, and taking out the ice, and keeping it in a perpendicular poſture, caſt into a ſcale weighed beforehand, and carefully faſtened to the bottom of the ice, more and more weight, till the mere weight broke the cylinder: and this we had thoughts to try in cylinders of differing diameters and lengths, but wanted conveniencies to make the experiments; (which if they were made, as ſome of our trials were, in the open air, and in places expoſed to ſome gelid wind, it would the better ſecure the ice from being weakened or thawed during the trials.)

4. We therefore attempted, by another way, to inveſtigate the ſtrength of ice. For we took a plate of it, of an uniform, and alſo of a conſiderable thickneſs, and with ſides cut parallel, that it might ſerve for a kind of lever, and placed it betwixt two wooden bars, whoſe diſtance we knew; and then laying on it a great weight, the centre of whoſe preſſion, as near as we could eſtimate, was equally, or in determinate meaſures, diſtant from the wooden fulcrums, we endeavoured to try, how great a weight it would ſupport; but in the village, where we made the trials, we could not get weights, that were conveniently ſhaped, and ponderous enough, to break it; and though we cauſed a man to ſtand upon it, yet neither could his weight break it; till he chanced to add an impreſſed force with his foot to the weight of his body. So that being unable to determine, what that additional and impreſſed force might amount to, almoſt all that we could ſafely conclude, either from this experiment, or ſome other ways of trial with ſcales, and other ways, that we made uſe of, (but for want of conveniencies unſucceſsfully) was, that the force of ice to ſupport weights is much greater than men can imagine; which ſeems ſomewhat the more ſtrange, becauſe it is not here in *England* ſo ſolid a body, as by this one would gueſs: for not only glaſs would readily ſcratch it deep enough, but even with common knives we could cut it, and that with great eaſe.

5. Yet one not inconſiderable account I was able to give my ſelf of the ſtrength of ice, which I find in my notes thus delivered.

[There was taken a piece of ice three inches long, and three broad, and ſomewhat leſs than a quarter of an inch thick; this was laid croſs-ways upon a frame, ſo that the two parts, on which the ice leaned, were diſtant three inches: then there was taken an iron, ſhaped like the figure of (the common arithmetical cypher, that denotes ſeven) 7, to whoſe hanging leg, if I may ſo call it, there was faſtened at the end, which was under the middle of the ice, a ſcale, into which ſeveral weights were put, ſuch as by ſome former trials we gueſſed to be almoſt as much as the ice would well ſuffer: after which, the horizontal leg of the iron was very gently laid upon the ice, as near as we could gueſs, in the middle of the diſtance, between the two ſides of the frame, and conſequently parallel to them both. Then the weights not proving altogether ſufficient to break the ice, we let them hang a while at it, and obſerved, how the edge of the incumbent leg of iron (which edge was * broad) did work it ſelf downwards into the ice; ſo that by our gueſs, when the ice broke, as after a while it did, it had loſt at one end of the inciſion, if I may ſo call it, half its thickneſs, and at the other, about a third part of it.

THE weights, that broke it, amounted to 17 pounds averdupois, and 117 ounces Troy.

6. THE experiment was repeated with all the former circumſtances, only the piece of ice was two inches and a half broad, and a quarter of an inch thick, and the diſtance of the frame was three inches, as before; the weights, that broke it, were 17 pounds averdupois, and 41 ounces Troy. The horizontal arm of the iron had melted ſomewhat more than half through the ice when it broke, *viz.* more than $\frac{2}{3}$ of the thickneſs at one end, and ſomewhat leſs than half at the other.

7. WE divers times intimated in ſome of the firſt ſections of our preſent hiſtory, that the addition of ſalt to ice did haſten the diſſolution of it, which though it may be eaſily proved by ſome other phænomena of our experiments, yet it will not be amiſs to mention here a couple of particular trials, by which we have more manifeſtly evinced it. And firſt, we divers times took a broad and flat plate of ice, leſs than a quarter of an inch thick, and having placed it horizontally upon a joint-ſtool, (a table, or any other flat piece of wood will do as well) we ſtrewed here and there a convenient quantity of bay-ſalt upon it; and though we obſerved, that, if the ſurfaces of the ice and ſtool were not both of them flat, and congruous enough, the ice would be thawed indeed, but the other part of the experiment would not well ſucceed; yet when we made the trial carefully and watchfully, the plate of ice partly thawed by the ſalt would be ſo firmly frozen to the ſtool it leaned on, that we were fain with an iron inſtrument to knock it all to pieces, before we could ſever it from the ſtool; into whoſe pores the ice newly generated by the experiment did pierce ſo deep, that, notwithſtanding our knocking, many little parcels of ice would continue to ſtick cloſe to the wood, whoſe pores they had invaded. But the circumſtances, which in this experiment made the moſt to our purpoſe, are theſe two; the one, that having ſometimes laid the ſalt but on a few, and ſomewhat diſtant parts of the plate, the intermediate parts would many of them remain unfrozen to the ſtool; whilſt thoſe, where the ſalt had been laid, were frozen ſo hard to it. And the other circumſtance is, that the groſſer grains of ſalt would ſo far diſſolve the ice, whereto they were contiguous, as (if I may ſo ſpeak) to bury themſelves therein; whilſt the other parts of the ice, upon which, or near which, no ſalt had been laid, kept their ſurfaces ſmooth and intire. We tried likewiſe two or three times to freeze a plate of ice to a flat piece of wood, by making uſe of aqua fortis, inſtead of common ſalt; but the experiment ſucceeded not well, though once we brought the ice to ſtick to the wood manifeſtly, but not ſtrongly.

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* The breadth was, I know not how, omitted in the note; but, as I remember, it was about an 8th part of an inch.

8. To this we ſhall add the following experiment, which, when we watchfully made it, ſucceeded well, and I find it among my notes ſet down in theſe terms.

[Solid fragments of ice having pretty ſtore of ſalt thrown on them, upon the firſt falling of the ſalt among the ice there was produced a little crackling noiſe, and for a good while after there manifeſtly aſcended out of ſeveral parts of the mixture, conveniently held betwixt a candle and the eye, a ſteam or ſmoke, like that of warm meat, though the night were rainy and warm, and though the morning had not been froſty.]

The mention here made of the crackling noiſe made by the ice upon the addition of ſalt, (which ſeemed to proceed from the crackling of the brittle ice, produced by the operation of the ſalt upon it) brings into my mind an experiment I had formerly made, whereof a greater noiſe of the ſame kind is a phænomenon, though the experiment were chiefly made for the diſcovery of the texture of ice: the event of the trial I find thus ſet down among my notes.

9. [We took ſome cakes of ice, each of the thickneſs between $\frac{1}{8}$ and $\frac{1}{4}$ part of an inch, but not ſo very compact ice, as to be free from ſtore of bubbles: ſome good aqua fortis dropped upon this did quickly penetrate it with a noiſe, that ſeemed to be the cracking of the ice, underneath which the ſour liquor was plainly to be taſted. Oil of vitriol did the ſame, but much more powerfully, and without ſeeming to crack the ice, which it paſt through; ſo that though but three or four drops were let fall upon the plate, it immediately ſhewed it ſelf in drops exceedingly corroſive on the other ſide of the ice. And the like ſucceſs we had with a trial made with the ſame liquor, upon three ſuch plates of ice frozen one upon the top of another.]

10. Having proceeded as far as we were able towards the bringing the ſtrength of ice to ſome kind of eſtimate, by ſuch experiments as we had opportunity to make here, we thought it not amiſs to ſeek what information we could get about this matter among the deſcriptions, that are given us of cold regions: but I have not yet found any thing to have been taken notice of to this purpoſe worth tranſcribing, except a paſſage in the archbiſhop of *Upſal*, wherein, though the eſtimate of the force of ice be, as we ſhall by and by ſhew, made after a groſs manner, yet ſince this it ſelf is more than I have met with elſewhere, I think it worth ſubjoining, as our author delivers it in theſe terms: *Glacies* (ſays he) *primæ & mediæ hyemis adeò fortis & tenax eſt, ut ſpiſſitudine ſeu denſitate duorum digitorum ſufferat hominem ambulantem, trium vero digitorum equeſtrem armatum; unius palmæ & dimidiæ, turmas, vel exercitus militares; trium vel quatuor palmarum integram legionem ſeu myriadem populorum, quemadmodum inferiùs de bellis hyemalibus memorandum erit.* Olaus M. Gent. Septentr. Hiſt. l. 1. c. 14.

But though this be ſufficient to afford us an illuſtrious teſtimony of the wonderful ſtrong coheſion of the parts of ice, yet we mentioned it but as a popular way of eſtimate, which may better embolden travellers, than ſatisfy philoſophers, in regard, that the author determines only the thickneſs of the ice, and not the diſtance of that part of it, that ſupports the weight from the ſhore or brink, on which, as on a hypomoclion, the remoteſt part of the ice does lean or reſt. And if we conſider the ice as a lever, and the brink or brinks, on which it is ſupported, as a ſingle or double fulcrum, the diſtance of the weight may be of very great moment in reference to its preſſure or gravitation on the ice, which may more eaſily ſupport the weight of divers men placed very near the prop, than that of one man placed at a great diſtance from it; as will be eaſily granted by thoſe, that are not ſtrangers to the mechanicks, eſpecially to the nature and properties of ſeveral kinds of levers. But not now to debate, whether in certain caſes, the ice we ſpeak of, may not receive ſome ſupport from the ſubjacent water, nor whether ſome other circumſtances may not ſometimes be able to alter the caſe a little, our very conſidering the ice as a ſingle or double lever, though it may hinder us from meaſuring the determinate ſtrength of ice upon *Olaus*'s obſervation, yet it will ſet forth the ſtrength of it ſo much the more, ſince by his indefinite expreſſions he ſeems ſufficiently to intimate, that when the ice has attained ſuch a thickneſs, its reſiſtance is equivalent to ſuch a weight, without examining on what part of the ice it chances to be placed.

11. THUS far our experiments concerning ice, with the appendix ſubjoined out of *Olaus* to the ſame purpoſe. We will now proceed to ſome of the obſervations we have met with in ſeamen's journals, and elſewhere. I ſay to ſome, becauſe to enumerate them all, would ſpend more time and labour than I can afford; and therefore I ſhall reſtrain myſelf to the mention of ſome few of the chiefeſt.

I. AND in the firſt place for confirmation of what I delivered, at the beginning of this ſection, from the report of a traveller into *Ruſſia*, touching the hardneſs of ice in thoſe gelid climates, in compariſon of our ice, which I have found it eaſy to ſcrape with glaſs, or to cut with a knife; I ſhall ſubjoin this paſſage of Captain *G. Weymouth*, in his voyage for the diſcovery of the North-weſt paſſage: 'As we were (ſays he) 'breaking off ſome of this ice, which was very painful for us to do, for it was 'almoſt as hard as a rock, *&c.*'

Purchas, Lib. 4. Chap. 13.

II. NEXT to ſhew, that it was not a ſuperfluous warineſs, that made me in a former ſection doubt, that even the ice made of ſea-water might be altogether or almoſt inſipid; I will ſubjoin, that I have ſince met with ſome relations, that ſeem to juſtify what is there delivered. And in one of our Engliſhmen's voyages into the Northern ſeas, I find more than one inſtance to my preſent purpoſe, though I ſhall here ſet down but one, which is ſo full and expreſs, that it needs no companions; our navigator ſpeaking thus; 'About nine of the clock in the forenoon, we came by a 'great iſland of ice, and by this iſland we found ſome pieces of ice broken off 'from the ſaid iſland; and being in great want of freſh water, we hoiſted out our 'boats of both ſhips, and loaded them twice with ice, which made us very good 'freſh water.'

Purchas, Lib. 4. cap. 13. pag. 813.

BUT all this notwithſtanding, I yet retain ſome ſcruple, till thoſe, that have better opportunity to make a more ſatisfactory experiment, ſhall eaſe me of it. For though by theſe narratives it ſeems more than probable, that the ice in the midſt of the ſea conſiſts but of the freſh particles of water, that plentifully concur to compoſe the ſea water; yet beſides that, in caſe the freſh water were taken, as ſome of that I have found mentioned in voyages, has confeſſedly been, from the top of the ice, it might poſſibly be no more than melted ſnow, which, as we elſewhere take notice, does in thoſe extreme cold regions eaſily freeze upon the ice it falls on, and oftentimes much increaſes the height of it: beſides this, I ſay, the argument from the inſipidneſs of the reſolved ice will conclude but upon ſuppoſition, that as that ice was found in the ſea, ſo it was alſo made of the ſea water; which though it may have been, yet I ſomewhat doubt, whether it were or no, ſince I find ſome navigators of the moſt converſant in the cold climates to inform us, that moſt of thoſe vaſt quantities of ice, that are to be met with about *Nova Zembla*, and the ſtrait of *Weigats*, and that choak up ſome other paſſages, whereby men have attempted to paſs into the ſouth ſea, are compoſed of the accumulation of numerous pieces of ice (cemented by intercepted, and then frozen, water) that are brought down from the great river *Oby*, and others; ſo that it may very well be ſuppoſed, that theſe * mountainous pieces of ice may be ſome of thoſe, which, upon the ſhattering of ice in bays and ſtraits, partly by the heat of the ſun, and partly by the tides, may be afterwards by the winds and currents driven all up and down the ſeas, to parts very diſtant from the ſhore; and ſome of theſe, it may be, that our countrymen met with, and obtained their freſh water from: which I the rather incline to think, becauſe that (as we ſhall have occaſion to obſerve in another ſection) the main ſea it ſelf is ſeldom or never frozen. But my ſcope in all this is but to propoſe a ſcruple, not an opinion.

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* Neither hereafter will I marvel, though the ſtrait of *Weigats* be ſtopped up to the North-eaſt, with ſuch huge mountains of ice, ſince the rivers *Oby* and *Jeneſce*, and very many more, whoſe names are not yet

III. The next and principal thing concerning ice is the bigneſs of it, which I find, by the relations partly of ſome acquaintances of my own, and partly of ſome navigators into the North, to be ſometimes, not only prodigious, but now and then ſcarce credible. And therefore, as I ſhall mention but few inſtances, that I have ſelected out of the beſt journals, and other writings I have met with, ſo I ſhall add a few more teſtimonies to keep them, by their mutual ſupport, from being entertained with a diſbelief, which their ſtrangeneſs would elſe tempt men to.

Of the vaſtneſs of ſingle mountains of ice, the moſt ſtupendous example, that, for aught I know, is to be met with in any language but ours, is that, which I formerly took notice of, out of the Dutch voyage to *Nova Zembla*, which was ninety-ſix foot high (that is, above twenty foot higher, than on a certain occaſion I found the leads of *Weſtminſter* Abbey to be.) But it is probable, that our Captain *James* met with as great, if not greater: for though in ſome places he mentions divers hills of ice, that were aground in 40 fathom water, and conſequently were as deep under water, as that newly taken notice of out of the Hollanders, *page* 14: and though he elſewhere mentions other pieces of no leſs depth, and twice as high as his top-maſt head, and this in *June:* yet elſewhere, and long after, relating his return home, he has this paſſage; *page* 106. 'We have ſailed through much mountainous ice, far higher than 'our top-maſt head: but this day we ſailed by the higheſt I ever yet ſaw, which was 'incredible indeed to be related.'

But the ſtupendouſeſt piece (for height and depth) of ſingle ice, that perhaps has been ever obſerved and meaſured by men, is that, which our famous Engliſh ſeaman Mr. *W. Baffin* (whoſe name is to be met with in many modern maps and globes) mentions himſelf to have met with upon the coaſt of *Greenland*, whoſe whole relation I ſhall therefore ſubjoin, not only becauſe of the ſtupendouſneſs of this piece of ice, but becauſe he takes notice of an obſervation, which I knew not to have been made by any, and comes ſomewhat near the eſtimate we formerly made of the proportion betwixt the extant and immerſed parts of floating ice; only the following eſtimate makes the extant part ſomewhat greater than we did; which may eaſily proceed from other men's having, as Mr. *Baffin* here does, grounded their computation upon what occurred to them at ſea, or in ſalt water, where the ice muſt ſink leſs than in freſh water, ſuch as my eſtimate ſuppoſed. Our navigator's words then are theſe: 'The '17th of *May* we ſailed by many great iſlands of ice, ſome of which were above 200 'foot high above water, as I proved by one ſhortly after, which I found to be 240 'foot high; and if the report of ſome men be true, which affirms, that there

Purchas, lib. 4. cap. 18. pag. 837.

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yet known, pour out ſuch a quantity thereof, that in a manner it is incredible: for it cometh to paſs in the beginning of the ſpring, that in places near unto the ſea, the ice, through the exceſſive thickneſs, and multitude thereof, doth carry down wood before it. And without doubt this is the cauſe, that about the ſhore of the ſtrait of *Weigats*, ſo great abundance of floating wood is every where ſeen: and whereas in that ſtrait near unto *Nova Zembla*, it is ſo extreme cold, it is no marvel, if in regard of the narrowneſs of the ſtrait, ſo huge heaps of ice are gathered and frozen together, that in the end they grow to ſixty or at leaſt to fifty fathoms thickneſs: ſays the Deſcription of the countries of *Siberia*, *Samojeda*, &c. extant in *Purchas*'s third part of his Pilgrim. *Lib.* 3. *Chap.* 7.

‘ is but one ſeventh part of ice above water, then the height of that piece of ice, ‘ which I obſerved, was one hundred and forty fathoms, or one thouſand ſix hundred ‘ and eighty foot from the top to the bottom. This proportion I know doth hold in ‘ much ice; but whether it do ſo in all, I know not.’

Thus far of the heighth and depth of ſingle pieces of ice: as for the other dimenſions (the length and breadth) I remember not, that I have read of any, that had the curioſity to meaſure the extent of any of them, excepting Captain *James*; whoſe ſhip being once arreſted between ſome flat and extraordinary large pieces of ice, he and his men went out to walk upon them, and he took the pains to meaſure ſome of the pieces, which he ſays he found to be 1000 of his paces long, *pag.* 17. And probably among ſo many mountains and iſlands of ice, there would have been found ſome intire pieces, of a greater extent than even theſe, if men had had the curioſity to meaſure them.

Hitherto we have treated of the bigneſs of ſingle pieces of ice; we will now proceed to ſay ſomething of the dimenſions of the aggregates of many of them, among which having elected four or five as the principal I remember myſelf to have yet met with, I preſume it will be ſufficient to ſubjoin them only.

‘ About ten of the clock we met with a mighty bank of ice, being, by ‘ ſuppoſition, ſeven or eight leagues, or twenty-four miles long,’ ſays that experienced Engliſh pilot *James Hall*, in his voyage of *Denmark* for the diſcovery of *Greenland*.

Another of our Engliſh navigators mentions, that even in *June*, ‘ all the ſea ‘ (wherein he was endeavouring to ſail) as far as he could ſee from the top of a high ‘ hill, was covered with ice; ſaving that, within a quarter of a mile of the ſhore, it ‘ was clear round about once in a tide.’ By which laſt clauſe, it ſeems, that this vaſt extent of ice was either one entire floating iſland, or at leaſt a vaſt bank or rand (as ſome ſeamen term it) of ice.

But the ſtrangeſt account of banks of ice, that I have yet met with in any ſober author, is, that which is mentioned by the learned French hydrographer, *Fournier*; who relates, that in the year 1635, the French fleet ſailing to *Canada*, met with ſeveral pieces of ice, as high as ſteeples, and particularly one, whether piece or bank of ice (for the French word *glace* may ſignify either) which they were troubled to coaſt along for above forty leagues. If this be the ſame ſtory, (as one may ſuſpect it to be, by the circumſtances of the place, and fleet) there is a great miſtake in another place, where our author ſpeaks of the vaſtneſs of the ice: but if it be another ſtory, as ſome other differing circumſtances argue, the French, it ſeems, met with ice far more ſtupendous, than even that already mentioned. For, (ſays our author) in the ſea, which waſhes *Canada*, there is often ſeen in the month of *Auguſt*, to paſs by, ices much bigger than ſhips. In the year 1635, the French fleet ſailing there, coaſted along, for three days and three nights, one, that was above 80 leagues long, flat in ſome places like vaſt champions, and high in other like frightful hills. The latter part of which paſſage may confirm what we formerly delivered in another ſection, concerning the unequal compagination of icy iſlands.

Hydographie du P. G. Fournier, liv. 9. cap. 29. compared with the 12th chapter of the ſame book.

To what has been ſaid touching the extent, and other dimenſions of floating, or at leaſt looſe pieces of ice, it will be fit to add ſomething of the extent of ice, coherent to one or both of thoſe ſhores, that bound the water, whoſe upper part is congealed. And in the firſt place, we ſhall, out of many inſtances to our preſent purpoſe, that might be borrowed from the writings of *Olaus Magnus*, ſelect this one memorable one, that ſhall ſerve for all: *Neque minori bellandi impetu* (ſays he) *Sueci*

Olai Mag. lib. 3. cap. 2. pag. 334.

*ac Gothi ſuper aperta glacie, quam in ipſa ſolidiſſima terra confligunt*; *imo, ut prius dictum eſt, ubi antea æſtivo tempore acerrima commiſſa ſunt bella navalia, eiſdem in locis glacie concreta, aciebus militari modo inſtructis, bombardis ordinatis, habentur horrendi conflictus. Adeo ſolida glacies eſt in equeſtribus turmis ſufferendis, ampliter vel ſtrictè collocatis.* I pretermit then, what he elſewhere relates of the voyages and wars made in winter by the Northern nations. They, that have lived in thoſe countries, relate as things moſt known and familiar, (what has been confirmed to me by more than one unſuſpected eye-witneſs) the long journeys, that are commonly taken upon the icy bridges, or rather plains, by travellers, with all their carriages, to very diſtant places. And that, which may bring credit to theſe ſtrange relations, by ſhewing, that no leſs unlikely ones are ſometimes true, is, what all *Europe* knows, that within theſe three years the whole Swediſh army, led on by their king, marched over the ſea to the iſland of *Zeeland*, where *Copenhagen*, the capital city of *Denmark*, ſtands *. But it may ſeem much more ſtrange, which I will therefore add, that as in the North countries frequently, ſo ſometimes even in the warmer regions of the Eaſt, the ſea itſelf has, by the cold, been congealed to a prodigious breadth. *Inſolitum eſt*, (ſaith *Bartholinus*) *quod refert Conſtantinus Manaſſes in Annalibus accidiſſe, Theophilo imperante, ut hyems ſæva mare cogeret in glaciem ad profunditatem ſanè immenſam, humidumque illud elementum, lapidis ad duritiem, fluxione prorſus ademptâ, redigeret.* And *Michael Glycas* relates, ‘ That in the year 775, the winter was ſo ſharp in the Eaſt, that along the coaſt, the ‘ ſea (he means the Mediterranean) was frozen for 50 leagues, and the ice was ‘ compacted as into a rock, 30 cubits deep; ſo ſtrange a quantity of ſnow ‘ likewiſe falling, that it was raiſed to the height of 30 cubits above the ice.’ Which likewiſe agrees very well with what we formerly noted, touching the poſſible increaſe of the height of ſome pieces of ice by the falling of the ſnow upon them.

Barthol. de nivis uſu cap. 6.

Glycas apud Fournier, liv. 9. cap. 19.

IV. It remains now, that we ſubjoin a few promiſcuous obſervations concerning ice, that are not ſo readily deducible to the three foregoing heads.

And we ſhall begin with what was taken notice of by the Dutch in their *Nova Zembla* voyage, where relating, how they faſtened their ſhips to a great piece of ice, to ſhelter themſelves from the ſtormy winds; ‘ There (add they) we went upon the ‘ ice, and wondered much thereat, it was ſuch manner of ice: for on the top it was ‘ full of earth, and there was found about forty eggs; and it was not like other ice, ‘ for it was of a perfect azure colour, like to the ſkies, whereby there grew a great ‘ contention of words amongſt our men, ſome ſaying, that it was ice, others that ‘ it was frozen land; for it lay unreaſonably high above the water, it was at ‘ leaſt eighteen fathom under the water, cloſe to the ground, and ten fathom above ‘ the water.’

The like blue colour in rocky pieces of ice, I remember I have ſomewhere found, to have been taken notice of by a modern † navigator; or whether the words of *Virgil*, concerning the frigid zone, *Cærulea glacie concretæ, atque imbribus atris*, belong to this ſubject, I leave others to conſider, nor ſhall I ſtay to examine, whether this blueneſs, that has been obſerved in ice, be always an inherent or permanent colour, or ſometimes one of thoſe, that are ſtyled emphatical.

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* —— *Sæpe aliàs & his annis fatalibus tam profundè congelavit (marina aqua) ut non tantum plauſtra, ſed integrum exercitum ad aliquot milliaria Germanica ſecure vexerit, &c. Inquit* T. Barthol. *de nivis uſu*, pag. 43.

† In the evening we were incloſed amongſt great pieces (of ice) as high as our poop, and ſome of the ſharp blue corners of them did reach quite under us. Captain *James*, page 6.

IT is very conſiderable, if it be true, what is related by *Olaus Magnus*, concerning the degenerating (if I may ſo ſpeak) of ice from its wonted hardneſs in the ſpring of the year. For in the ſame chapter, where he gives us the lately tranſcribed account of the ſtrength of ice in thoſe northern countries, after having interpoſed ſome other paſſages, he ſubjoins theſe words; *Liqueſcente tamen glacie ad principium Aprilis, nullus ejus ſpiſſitudini, minus fortitudini, niſi in aurora, ambulando confidit, quia ſolis diurno aſpectu tam fragilis redditur, ut quæ equeſtres armatos paulo ante portaverat, vix hominem nunc ſufferre poſſit inermem.* Olaus, lib. 2. cap. 14.

THIS puts me in mind to add, that oftentimes in the writers of journeys and voyages, we meet with mention of great noiſes made by the breaking of ice; and in this very chapter our archbiſhop taking notice of the clefts, that ſome time happen in champions of ice, adds, ‘That when the ice chances thus to open, eſpecially if it be ‘in the night, the noiſe of it may be heard a far off, like the loud and horrid noiſe of ‘thunder, and of earthquakes.’ And on this occaſion may be ſubjoined a couple of paſſages extant in different places of the formerly mentioned *James Hall*'s voyages: the firſt is thus delivered; ‘When we met with a huge and high iſland of ice, we ‘ſteering hard to board the ſame, and being ſhot a little to northwards of it, there ‘fell from the top thereof ſome quantity of ice, which in the fall did make ſuch a ‘noiſe, as though it had been the report of five cannons.’ But the next paſſage is more directly pertinent to our preſent ſubject, and is couched in theſe words; ‘About ‘twelve of the clock this night, it being ſtill calm, we found our ſelves ſuddenly ‘compaſſed round about with great iſlands of ice, which made ſuch a hideous noiſe, ‘as was moſt wonderful, ſo that by no means we could double the ſame to the weſt‘ward: wherefore, *&c.*’

OF theſe kind of icy thunders (as ſome travellers call them) there are divers inſtances to be met with, mentioned in the ſeveral voyages of the Hollanders, and particularly in thoſe to *Nova Zembla:* but many of thoſe noiſes ſeem to be made by the daſhing of the great pieces of ice againſt one another; but if it happens, when the ice (as ſometimes it is ſaid to do) ſeems to cleave, as it were, of its own accord; to us, that live in a temperate climate, it may be a matter of ſome diſpute, whence theſe loud ruptures of ice may proceed. For *Olaus Magnus*, in the chapter above cited, does not improbably aſcribe them to the warm exhalations, that in ſome places aſcend out of the ground. And I remember, in favour of this opinion, that I once cauſed divers pieces of thick ice to be brought out of a cool place into a ſomewhat warm room, and liſtening, obſerved a noiſe to come from them, as if it had been produced by ſtore of little cracks made in them; but ſomewhat or other prevented me from repeating the experiment, and ſatisfying my ſelf about the conjecture. But having lately inquired of an intelligent Polander, that has travelled much upon theſe icy plains, he agreed with our author, and others, as to the frightful noiſes, that are produced by theſe cracks of ice, but affirmed, upon his own obſervation, (for that I particularly inquired after) that theſe great clefts were often made, not by thawing heat, but by exceſſive cold, and that he had taken notice of them in extremely ſharp weather. Indeed we ſometimes obſerve, that in very bitter froſts the frozen ground will cleave, as we elſewhere have occaſion to take notice. But whether that be not a different caſe from this, or whether the Polonian gentleman were not miſtaken, or whether both theſe mentioned accounts, of the cleaving of ice, may on different conjunctures of circumſtances take place, we leave to farther inquiry.

THERE is a tradition concerning ice, about the famous *Vulcano Hecla*, in *Iceland*, which, though verily believed among the ſuperſtitious vulgar of thoſe parts, is ſpoken of ſo ſlightly by *Bleſkenius*, who being upon that coaſt, had the curioſity to ſail purpoſely thither, that I think it not worth while to take any farther notice of it. But it were too tedious to ſet down in this ſection, (which the ſtrangeneſs and variety of the theme has made ſo prolix already) the other things, that may be mentioned without impertinency concerning ice; and therefore we ſhall here deſiſt from ſo laborious a taſk, as alſo omit the handling of ſnow and hail: for though they are reducible to ice, yet I ſhall at leaſt ſuſpend the treating of them, partly becauſe *Bartholinus* and meteorologiſts have ſaved much of my labour, and partly for the reaſon newly intimated: ſo that we ſhall conclude this ſection, as ſoon as we have taken notice, that there is yet ſomewhat relating to ice, which, being in it ſelf conſiderable, and whereof hitherto no experimental account appears to have been given, what we our ſelves have tried about it, may challenge to be treated of apart.

Olaus Magnus, lib. 11. & Blefkenius in Purch. l. 3. c. 22.

## TITLE XVI.

### *Experiments and obſervations touching the duration of ice and ſnow, and the deſtroying of them by the air and ſeveral liquors.*

1. IT may be an experiment, as well inſtructive as new, to determine, what liquor diſſolves ice ſooner than others; and in what proportion of quickneſs the ſolutions in the ſeveral liquors are made. For men have hitherto contented themſelves to ſuſpect in general, that there are other liquors potentially hot, wherein ice will ſooner diſſolve, than it will in water. But this opinion either being grounded upon no experience at all, or taken up upon the ſight of what happens to pieces of ice, which no care was taken to reduce to the ſame bulk and figure, no more than to meaſure attentively how long one outlaſted the other; we thought fit to try, if we could not bring this matter to experiment, and make a determination in it, though not exactly true, yet leſs remote from exactneſs, than had been yet, for aught I know, ſo much as attempted.

2. In order to this, we procured ſome bullet moulds, and having firſt carefully ſtopped the little crevice, that is wont to remain betwixt the two halfs of the mould, with a good cloſe cement, we afterwards filled them with water, and carefully cloſed up the orifice of the hole, at which the water was poured in; and then ſetting the mould to freeze in ice and ſalt, we found it difficult enough to keep the water (more or leſs of it) from running away through ſome unperceived paſſage, before the cold could have time by congealing it to arreſt it. But after a while, when we had thus made a bullet of ice, we found it a new and greater difficulty to get it whole out of the moulds, without warming them; for by that way we could indeed looſen the ice, but then we could not avoid thawing it too, and that moſt times not uniformly: wherefore we tried by greaſing the inſide of the moulds to keep the ice from ſticking ſo cloſe to them, (notwithſtanding the diſtenſion the water ſuffered by its being frozen) but that we might pick out the bullet entire; and this ſucceeding well enough, we hoped by this way to obtain our end, which was to have a competent number of pieces of ice of equal bulk, and of the ſame figure, to be put at once to thaw in ſeveral liquors. But we could by no means procure moulds, which had any number of diſtinct cells of the ſame bigneſs, thoſe long pairs of moulds, that were to be met with in ſhops, having their diſtinct cells generally made on purpoſe of very different bigneſſes, which rendered them altogether uſeleſs for our deſign. Wherefore we were fain, for want of an exacter way, to take a glaſs pipe of the moſt even and cylindrical that we had, and of a bore capable to admit a big man's little finger. This glaſs being ſtopt at one end, and kept open at the other, was filled to the height of about half a foot or more of fair water; and ice and ſalt being heaped up about it, that the

cold might reach as far as the water did, it was quickly frozen. In the mean while I had cauſed ſeveral wide-mouthed glaſſes to be brought into my chamber (wherein, by reaſon of ſome indiſpoſition, that hindered me from going abroad, I kept ſome fire) and having poured ſeveral liquors into theſe glaſſes, which had been placed all on a row, we ſuffered them to reſt there a while, that the ambient air might have time to reduce them, as far as it could, to its temper, and conſequently to the ſame temper as to heat and cold: and then, with the warmth of one hand, the included ice being looſened from the glaſs, as it was taken out, and a ruler divided into inches and eighths, being laid alongſt it, with a knife a little warmed, the ice was ſoon, and yet not careleſly, divided into ſeveral ſmall cylinders of three quarters of an inch apiece; and theſe cylinders thus reduced to as ſenſible an equality as we could, were nimbly and carefully put into the ſeveral liquors hereafter to be mentioned. And whilſt we our ſelves watched very attentively, till each of theſe icy cylinders was quite, and yet but juſt diſſolved, we cauſed others to keep time by the help of a pendulum, whoſe vibrations were each a ſecond minute, (or 60th part of a common minute, whereof 60 go to make an hour) and it was eaſy for thoſe we appointed, to watch the vibrations of the pendulum, notwithſtanding the quickneſs of its motion, becauſe it was fitted to a little inſtrument purpoſely contrived for ſuch nice obſervations, wherein a long index moving upon a divided dial-plate did very manifeſtly point out the number of the diadromes made by the pendulum.

3. THIS experiment was afterwards repeated twice with cylinders of ice, each of them an inch long; and though the ſucceſſes of theſe trials were various enough, yet we ſhall ſubjoin both the former, (as being made with more advantage, than the laſt) that the more light may be gathered from them, and that at leaſt we may diſcover, how difficult it is to make ſuch experiments in this matter, as that all the nice circumſtances of them may ſafely be relied on.

### I. *Trial.*

1. OIL of vitriol, where a cylinder of ice, of an inch long, being put into, laſted five minutes.
2. SPIRIT of wine, (in which the ice ſunk) laſted 12 minutes.
3. AQUA FORTIS laſted 12½ minutes.
4. WATER laſted 12 minutes.
5. OIL of turpentine laſted (not good) 44 minutes.
6. AIR laſted 64 minutes.

### II. *Trial.*

1. IN oil of vitriol, where an inch of cylindrical ice laſted 3 minutes.
2. IN ſpirit of wine, laſted 13 minutes.
3. IN water, laſted 26 minutes.
4. IN oil of turpentine, laſted 47 minutes.
5. IN ſallet oil, laſted 52 minutes.
6. IN the air, laſted 152 minutes.

4. WE likewiſe thought it worth trying, whether there would be any difference, and how much difference there would be in the duration of pieces of ice of the ſame bulk and figure, ſome of them made of common water, and others of frozen wine, milk, oil, urine, and other ſpirituous liquor; theſe ſeveral pieces being expoſed to be thawed in the ſame air, as other ambient liquor.

5. We alſo tried, whether motion would impart a heat to ice, by nimbly rubbing a ſtrong piece of ice upon a plate of ice; and though this ſeemed to haſten the diſſolution in that part of the icy plate, where the attrition had been made, yet we were unwilling to determine the matter, till further and exacter trial have been made.

6. And this brings into my mind an experiment, that has by ſome been thought very ſtrange. The occaſion I remember was, that I received the laſt winter the honour of a viſit from a nobleman of great eminency and learning, who chancing to come in, while I was making ſome trials with ice, would needs know what I was doing with it; but the preſence of a very fair lady, in whom *Hymen* had made him happy, and of ſome other company of that ſex, that he brought along with him, inviting me to give him the anſwer, that I thought would be moſt ſuited and acceptable to his company, I merrily told him, that I was trying, how to heat a cold liquor with ice; and to ſatisfy him, that was no impoſſibility, I held out an open-mouthed glaſs, full of a certain liquor (which for ſome juſt reaſons I do not deſcribe, but do plainly teach it in an opportuner place) and deſired them to feel, whether it were not actually cold. And when they were ſatisfied it was ſo, I choſe among the pieces of ice, that lay by me, that I judged by the eye to be fit for my purpoſe, (for every piece was not ſo, for a reaſon I elſewhere ſhew) and throwing it into this liquor, it did not only in a trice vaniſh in it, but the lady, I was mentioning, ſeeing the liquor ſmoke, and advancing haſtily to try, whether it were really warm, found it ſo hot, that ſhe was quickly fain to let it alone, and had almoſt burnt her tender hand, with which ſhe had, in ſpite of my diſſuaſion, taken hold of the glaſs, which her lord himſelf could ſcarce endure to hold in his. But this experiment, which for the main I have repeated before competent witneſſes, though it be not impertinent to the *Hiſtory of Cold*, yet I ſhall not build much upon it; becauſe, how ſtrange ſoever many have been pleaſed to think it, I ſhall elſewhere ſhew, that I made uſe of a certain unperceivable ſleight, which, in my opinion, did as well, as the nature of the liquor and the texture of the ice, contribute to the ſuddenneſs and ſurprizingneſs of the effect.

7. But to return to the duration of the effects of cold, I think thoſe much miſtaken, who imagine, that the effects of cold do continually depend upon the actual preſence and influence of the manifeſt efficients, as the light of the air depends upon the ſun, or fire, or other luminous body, upon whoſe removal it immediately ceaſes. For when cold agents have actually brought a diſpoſed ſubject to a ſtate of congelation, though the manifeſt efficient cauſe ceaſe from acting, or perhaps from being, the effect may yet continue. For in moſt caſes, if a certain texture be once produced in a body, it is agreeable to the conſtancy of nature, that it perſevere in that ſtate, till it be forcibly put out of it, by ſome agent capable to overpower it. And though we uſually ſee ice and ſnow, as it were of their own accord to melt away, when the froſty conſtitution of the air ceaſes; yet the cauſe of that may be not barely the ceſſation of froſty weather, but that thoſe eaſily diſſoluble bodies are expoſed to the free air, which being heated by the ſun-beams, and perhaps by calorifick expirations from the earth, is furniſhed with an actual cauſe, upon whoſe account it deſtroys the texture of the ice and ſnow. But even here above ground, if ſnow be well compacted into great maſſes, in which, by reaſon of the cloſeneſs of the little icicles, but little air is allowed to get between them, I have ſeen ſuch maſſes of ſnow laſt ſo long, not only in thawing, but in rainy weather, as to be wondered at; and if ſuch ſnow (or ice) be kept in a place where it may be fenced from the ſun, and other external enemies, though the place, it is lodged in, be not any thing near cold enough to produce ice, yet it will, as ſome trial hath taught me, preſerve ice and ſnow for a very long time.

## *Appendix to the* XVIth *Title.*

AN eminent inſtance to confirm what is delivered at the cloſe of the foregoing ſection, is afforded us by the conſervatories, wherein ſnow and ice are kept all the ſummer long. Of theſe I have ſeen in *Italy*, and elſewhere; but ſuppoſing I had the command of ſome Italian, and other books, wherein I ſhould meet with the dimenſions, and other circumſtances, that belong to them, my finding my expectation diſappointed by thoſe books, makes me think it very well worth while to ſubjoin ſomewhat about things, that may give us opportunity of making a multitude of experiments about cold. And therefore meeting the other day (by good chance) with my ingenious friend Mr. *J. Evelyn*, his inquiſitive travels, and his inſight into the more polite kinds of knowledge, and particularly architecture, made me deſire and expect of him that account of the Italian way of making conſervatories of ſnow, that I had miſſed of in ſeveral authors; and having readily obtained my deſire of him, I ſhall not injure ſo juſtly eſteemed a ſtyle as his, to deliver his deſcriptions in any other words, than thoſe enſuing ones, wherein I received it from him.

[THE ſnow-pits in *Italy*, *&c.* are ſunk in the moſt ſolitary and cooled places, commonly at the foot of ſome mountain or elevated ground, which may beſt protect them from the meridional and occidental ſun: 25 foot wide at the orifice, and about 50 in depth, is eſteemed a competent proportion. And though this be excavated in a conical form, yet it is made flat at the bottom or point. The ſides of the pit are ſo joiced, that boards may be nailed upon them very cloſely jointed. (His Majeſty's at *Greenwich*, newly made on the ſide of the Caſtle-hill, is, as I remember, ſteened with brick, and hardly ſo wide at the mouth.) About a yard from the bottom is fixed a ſtrong frame or treſſel, upon which lies a kind of wooden grate; the top or cover is double thatched, with reed or ſtraw, upon a copped frame or roof, in one of the ſides whereof is a narrow door-caſe, hipped on like the top of a dormer, and thatched; and ſo it is compleat.

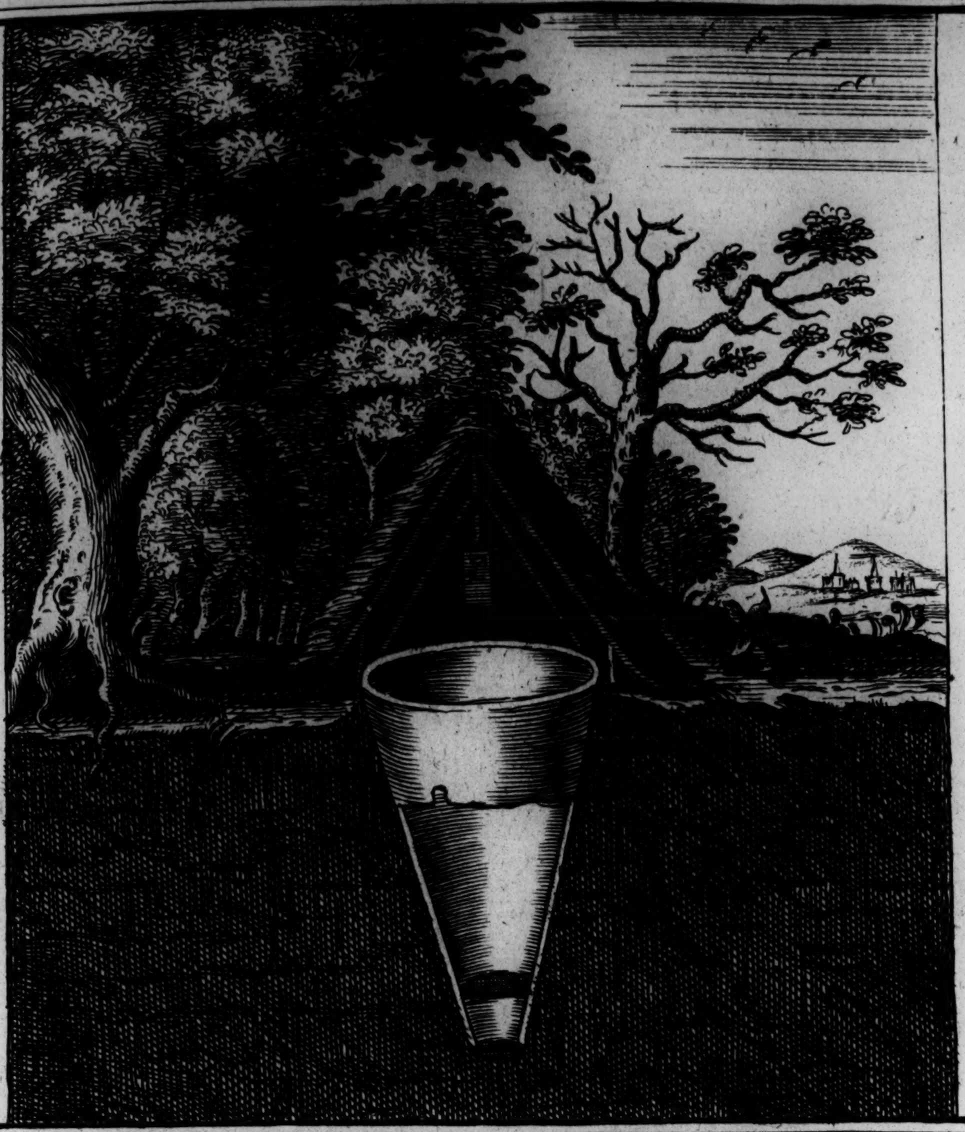
I have ſeen alſo the ſides lined with reeds long-ways, inſtead of boarding or ſteening.

### *To conſerve ſnow:*

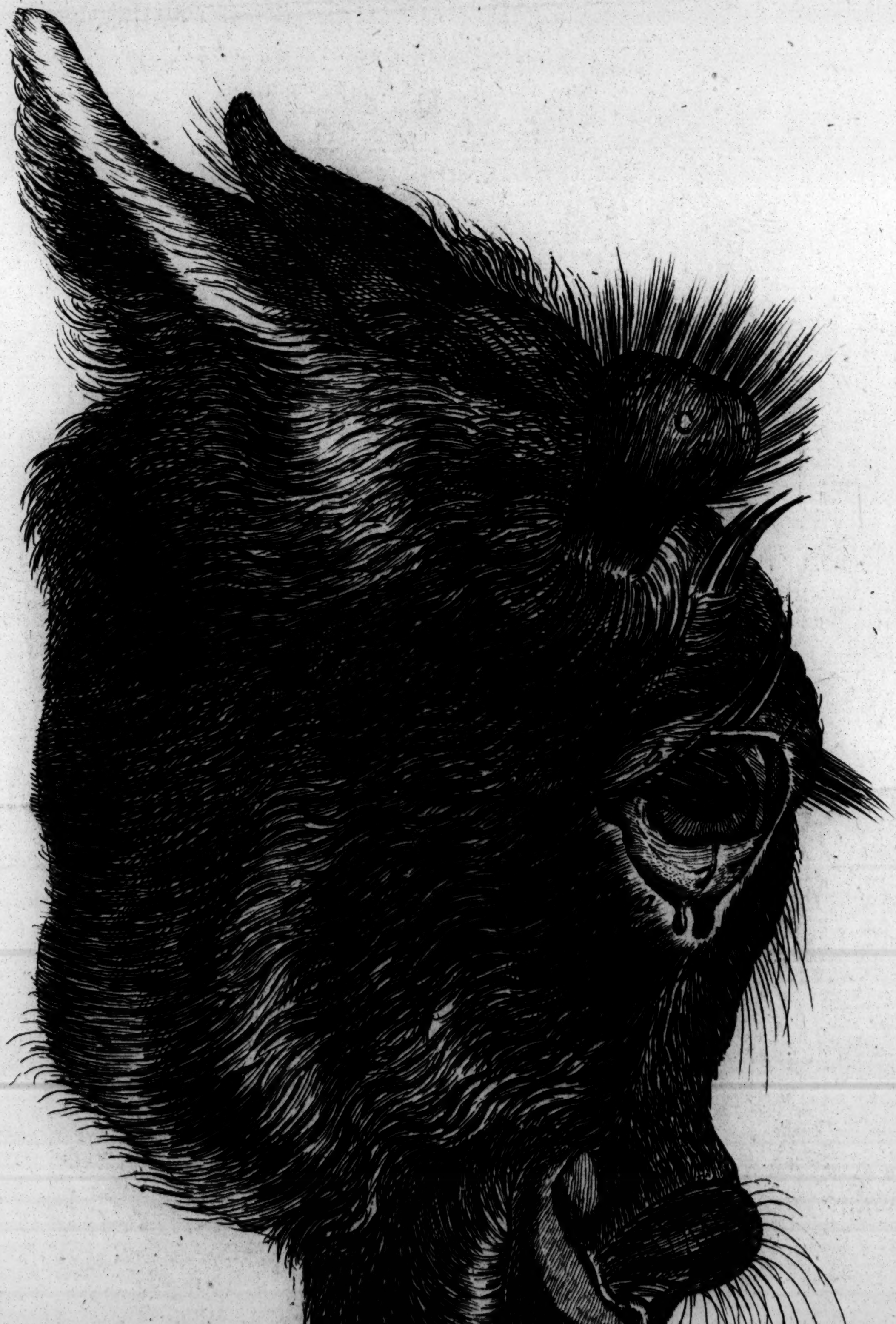
THEY lay clean ſtraw upon the grate or wattle, ſo as to keep the ſnow from running through, whilſt they beat it to a hard cake of an icy conſiſtence, which is near one foot thick: upon this they make a layer of ſtraw, and on that ſnow, beaten as before; and ſo continue a bed of ſtraw, and a bed of ſnow, S. S. S. till the pit be full to the brim. Finally, they lay ſtraw or reed (for I remember to have ſeen both) a competent thickneſs over all, and keep the door locked. This grate is contrived, that the ſnow melting by any accident in laying, or extraordinary ſeaſon of weather, may drain away from the maſs, and ſink without ſtagnating upon it, which would accelerate the diſſolution, and therefore the very bottom is but ſlightly ſteened. Thoſe, who are moſt circumſpect and curious, preſerve a tall circle of ſhady trees about the pit, which may rather ſhade, than drip upon it.]

THUS far this learned gentleman's account of conſervatories of ſnow. And on this occaſion I might add what the Dutch in their *Nova Zembla* voyage relate, namely, that 'the three and twentieth of *June*, though it were fair ſun-ſhiny weather, yet 'the heat was not ſo ſtrong, as to melt the ſnow, to afford them water to drink; 'and that in ſpite of their being reduced to put ſnow in their mouths, to melt it 'down into their throats, they were compelled to endure great thirſt.' But becauſe it was in ſo cold a climate, that this duration of the ſnow was obſerved, I ſhall take notice, that in the *Alps*, and other high mountains, even of warmer climates, though

VO[illegible] *Pl.* 2.
*p.* [illegible]



VOL. II. *Pl.* 3.
*p.* 735.



J. Mynde sc.

the ſnow doth partly melt towards the end of ſummer; yet in ſome places, where the reflection of the ſun-beams is leſs conſiderable, the tops will even then remain covered with ſnow, as we among many others have in thoſe countries obſerved. And for further confirmation of the doctrine delivered at the end of this 16th title, I ſhall ſubjoin a paſſage; which having unexpectedly met with in an unlikely place of Captain *James*'s voyage, I think not fit to leave unmentioned here; not only becauſe it is the ſole artificial obſervation, that I yet met with, concerning the laſting of ice, and ſo may recommend to us the ingenuity of an author, whoſe teſtimony we ſomewhat frequently make uſe of; but becauſe the obſervation is in itſelf remarkable, and notwithſtanding the difference of places may ſerve for the purpoſe we alledge it: our navigator's words are theſe; *page* 101. 'I have in *July*, and in the beginning of 'August, taken ſome of the ice into the ſhip, and cut it ſquare two foot, and put it 'into the boat, where the ſun did ſhine on it with a very ſtrong reflex about it. And 'notwithſtanding the warmth of the ſhip (for we kept a good fire) and our breath'ings, and motions, it would not melt in eight or ten days.' And it is alſo conſiderable to our preſent purpoſe, what the ſame author elſewhere has about the durableneſs of the congelation of the ground not yet thawed at the beginning of *June*. 'For the ground (ſays he, *pag*. 65.) was yet frozen; and thus much we 'found by experience in the burying of our men, in ſetting up the king's ſtandard 'towards the latter end of *June*, and by our well at our coming away in the 'beginning of *July*; at which time upon the land, for ſome other reaſons, it was 'very hot weather.'

## TITLE XVII.

### *Conſiderations and experiments touching the* Primum Frigidum.

1. THE diſpute, which is the *Primum Frigidum*, is very well known among naturaliſts: ſome contending for the earth, others for the water, others for the air, and ſome of the moderns for nitre: but all ſeeming to agree, that there is ſome body or other, that is of its own nature ſupremely cold, and by participation of which, all other cold bodies obtain that quality.

2. BUT for my part, I think, that, before men had ſo hotly diſputed, which is the *Primum Frigidum*, they would have done well to inquire, whether there be any ſuch thing or no, (in the ſenſe newly expreſſed.) For though I make ſome ſcruple, reſolutely to contradict ſuch ſeveral ſects of philoſophers, as agree in taking it for granted, yet I think it may be not irrationally queſtioned, and that upon two or three accounts.

3. FOR (firſt) it is diſputable enough, as we ſhall hereafter ſee, whether cold be (as they ſpeak) a poſitive quality, or a bare privation of heat: and till this queſtion be determined, it will be ſomewhat improper to wrangle ſolicitouſly, which may be the *Primum Frigidum*. For if a body's being cold, ſignify no more than its not having its ſenſible parts ſo much agitated, as thoſe of our ſenſories, by which we are wont to judge of tactile qualities; there will be no cauſe to bring in a *Primum Frigidum*, upon whoſe account particular bodies muſt be cold: ſince to make this or that body ſo, it ſuffices, that the ſun or the fire, or ſome other agent, whatever it were, that agitated more vehemently its parts before, does now either ceaſe to agitate them, or agitate them but very remiſsly, ſo that, till it be determined, whether cold be a poſitive quality, or but a privative; it will be needleſs to contend, what particular body ought to be eſteemed the *Primum Frigidum* (in the ſenſe above ſpecified.)

4. SECONDLY, though it be taken for granted, not only by the ſchools, but by their adverſaries the chymiſts, that heat and moiſture, dryneſs and gravity, and I know not how many other qualities, muſt have each of them a πρῶτον δεκτικὸν, or a principal ſubject to reſide in, upon whoſe account, and by participation of which, that quality belongs to the other bodies, wherein it is to be met with; though this be ſo, I ſay, yet we have * elſewhere fully enough manifeſted, that this fundamental notion, upon which much of the doctrine of qualities is both by Ariſtotelians, and vulgar chymiſts, ſuperſtructed, is but an unwarrantable conceit; and therefore not ſufficient for a wary naturaliſt to build the notice of a *Primum Frigidum* upon; there being indeed many qualities, as gravity, and figure, and motion, and colour, and ſound, *&c.* of which no true and genuine πρῶτον δεκτικὸν can (for aught I could ever yet diſcover) be aſſigned. And becauſe heat and cold are looked upon as diametrically oppoſite qualities, we may conſider, that it will be very hard to ſhew, that there is a πρῶτον δεκτικὸν of heat; ſince ſtones, and metals, and plants, and animals, and (very few excepted) all conſiſtent bodies, we are converſant with, may by motion be brought to heat; which to attribute to the participation of ſome portion or other of the imaginary element of fire, is not only precarious (being affirmed by many, and proved by none) but erroneous, or at leaſt needleſs, as we have more at large declared in other papers.

* In the Sceptical Chymiſt.

The Dialogues about Heat and Flame.

5. A THIRD thing, that induces me to queſtion, whether there be a *Primum Frigidum*, is, that among thoſe bodies, that the chiefeſt ſects of philoſophers, whether ancient or modern, have pitched upon, there is not any, that ſeems clearly to deſerve the title of *Primum Frigidum.* But to make this appear, we muſt diſtinctly (though as briefly as our deſign will permit) conſider thoſe four ſeveral bodies, which we have (at the beginning of this ſection) taken notice of, to ſtand in competition, in the opinions of philoſophers, for the title of *Primum Frigidum*.

6. FIRST then, *Plutarch* and others contend, that it is the earth; but to omit other arguments, we ſee, that the earth is frozen not by its own cold, but by its vicinity to the air, as may be argued by this, *viz.* that the congealing cold, even in the midſt of winter, affects but the ſurface of the earth, where it borders on the air, and ſeldom pierces above a few feet, or, at moſt, yards, beneath that part, wherein the earth is expoſed, and immediately contiguous, to the air; as may appear by what we have formerly delivered concerning the ſmall depth, to which froſts reach in the ground. And therefore if the earth be protected from the air (though by ſo cold a body as water) it may be kept unfrozen all the winter long; as may be gathered from that remarkable practice in the great ſalt-marſhes of the French iſlands of *Xaintonge*, where, as a diligent writer of that country, very well verſed in the making of the French ſalt, informs us, when once the ſeaſon of coagulating ſalt by the heat of the ſun is quite paſt, the owners are careful, by opening certain ſluices, to overflow all the banks, and dams, that make and divide the ſalt-ponds, and ſerve for the workmen to paſs to and fro: for (ſays my author in his own language) if they left thoſe marſhes (or ſalt-works) uncovered, the froſt would make ſuch havock amongſt them, that it would be neceſſary to make them up again every year; but by means of the water they are preſerved (or kept in repair) from year to year. Which practice I the rather mention, becauſe the hint, it affords, as it is conſiderable to our preſent purpoſe, ſo it may on ſome occaſions be applicable to practices uſeful to human ſociety.

7. BESIDES, the earth being (according to thoſe we reaſon with) the coldeſt, heavieſt, and ſolideſt of elements, it is not ſo probable, as to excuſe them from need of proving it, that thoſe exceſſively cold agents, that freeze the clouds into ſnow and

hail, ſhould be terrene exhalations carried up to the middle region of the air; eſpecially ſince it muſt be done by agents, either hard to be gueſſed at, or conſiderably hot. And it is not eaſy to give a reaſon, why, if elementary corpuſcles, ſteaming from the earth, have ſuch a congealing cold, where they are diſunited, and but interſperſed among the particles of air; the maſs of the earth it ſelf, whence thoſe exhalations are ſuppoſed to proceed, ſhould not be able alſo to congeal water, ſince the terreſtrial corpuſcles being more thick ſet, and united in a clod of earth, than in an equal portion of the atmoſphere, it ſeems, that where the frigorifick matter is more denſe, the cold ſhould be more vehement; as philoſophers obſerve, that heat is more intenſe in a glowing bar of iron, than an equal portion of the flame of kindled ſtraw.

8. But (not to repeat what we formerly mentioned about cold's being a privation) there is another argument againſt the earth's being the *Primum Frigidum*; and that is taken from the ſubterraneal fires, which breaking forth in many places of the earth, as in *Ætna*, *Veſuvius*, *Hecla*, the *Pico of Teneriffe*, &c. ſeem to argue a ſubterraneal fire; upon whoſe exiſtence not only many chymiſts build great matters, but even divers philoſophers have adopted it, as to employ it as one argument of the earth's being naturally neither hot nor cold. The mention of this ſubterraneal fire brings into my mind ſome things, that I have met with amongſt good, though not claſſick, authors, and amongſt men, that have been either diggers of, or converſant in, mines, not improper to be here taken notice of. For though I do not now intend to declare my opinion about the central fire, either of the chymiſts or Carteſians, and though the examples newly mentioned, and ſuch other, ſeem to me but very inconſiderable, in reference to the whole earth; yet it is obſervable to our preſent purpoſe, that there ſhould be ſo much ſubterraneal heat or warmth, at leaſt generally to be met with. For even where there appear no manifeſt ſigns of ſubterraneal fires, I have known thoſe, that were wont to go to the bottom of deep mines, complain, that a very little exerciſe would put them into a great ſweat; and a learned and experienced French doctor, that hath written in his own language, of ſtones and jewels, affirms, that in ſuch mines the ſubterraneal vapours and exhalations, are viſibly ſo abundant, and likewiſe ſo hot, that the mine-men are conſtrained (which a perſon I ſpoke with affirmed to me, touching himſelf) to work in their ſhirts, by reaſon of the great heat they there felt. And though I would have been glad to know, whether thoſe deep places would have appeared as hot, when judged of by a ſealed weather-glaſs, as they did to the mine-mens ſenſories, becauſe of ſome little doubt I harboured, whether much of that copious ſweating, and ſeeming heat, might not proceed from the thickneſs of the dampiſh air, and its unfitneſs for reſpiration; yet, becauſe a virtuoſo, that had a lead-mine of his own, in which he wrought himſelf for curioſity, anſwered me, that he was not wont to find any difficulty of breathing in the place, where he was ſo apt to ſweat; and ſince I find not, that others have complained of having their reſpiration incommodated in ſuch places, unleſs by accidental damps, my ſcruple was much abated; and the rather, becauſe the author lately mentioned expreſsly affirms, that the ſudorifick heat (if I may ſo ſpeak) is to be found in the bowels of the earth, as well in ſummer as in winter, which prevents the aſcribing of it to *Antiperiſtaſis*. And in other places than mines it is generally obſerved, that wells and ſprings freeze not, if the place whence the water is drawn be very deep; but, as we have obſerved elſewhere, that it oft comes up ſmoking, and, as it were, reeking; which argues, that at the leaſt the earth, wherein it was harboured, or through which it paſſed, was, if not warm, free from ſuch a degree of cold, as might be expected in the earth, if it were the *Primum Frigidum*. Nor can it be reaſonably pretended, that the ſubterraneal

De Claves au ſecond Livre des pierres & pierreries, cap. 2.

Ibid.

ſubterraneal heat comes from the beams of the ſun, ſince learned men have obſerved, that thoſe heat not the earth above ſix or ſeven foot deep even in Southern countries; and though we ſhould allow them to pierce three times as far, yet that would not be conſiderable to the depth of the mines above-mentioned; and if the lower part of the earth were of its own nature cold, and received the heat it diſcloſes only from the ſun and ſtars, the deeper men dig, the leſſer of heat and ſteams they would meet with; whereas the above-cited French mineraliſt affirms, that the lower they go, the more vapours, exhalations, and heat they find.

Monſieur de Claves, liv. II. cap. 8.

9. BUT becauſe this learned man delivers this circumſtance in a dogmatical, rather than an hiſtorical way, I will add ſomewhat out of a relation (whence I have * elſewhere taken other particulars) made by a French phyſician likewiſe, that had the curioſity to deſcend himſelf into the deep mines of *Hungary*; ſome of which, that he went down into, may be collected by his narrative, to have three or four hundred fathom, that is, eighteen or twenty-four hundred foot of perpendicular depth. This author then relates, that after he had deſcended about 80, or 100 fathoms, he came into a very warm region of the earth, which laſted to the bottom of the mine, and is ſo hot both winter and ſummer, that the labourers are wont to work in it without their clothes, and he was ſcarce able to indure the heat of it, although the external air were very hot, the weather being very fair, and the month *July* †. He adds, that he having demanded of the overſeer of the mine, whence this heat came, he was anſwered to that and ſeveral other queſtions, that it came from the lower parts of the earth; that wherever they dig the ground, after they are come to ſuch a depth (which he elſewhere mentions to be about 80 or 100 fathom) they feel no more any cold, but a perpetual heat, how deep ſoever they dig, (‡ yet without obſerving, that after they are once got into that warm region, they find the heat ſenſibly increaſe, the nearer they approach to the centre of the earth, unleſs by accident they happen to dig through veins of hotter minerals). And theſe anſwers (ſubjoins my author) I received not in one mine alone, or from a ſingle overſeer, but in all the mines, and from all the maſters of them; ſo that if theſe were not miſtaken, we may ſafely conclude, that as far as experience can inform us, the body of the earth in its lowermoſt parts, where it is preſumed to be coldeſt, is every where, and that conſiderably, hot. I ſaid, *if theſe mine-men were not miſtaken,* becauſe having been in the bottom of ſome mines myſelf, though I find it acknowledged, that it is ſtill warm in the bottom of deep ones; yet I confeſs, I ſomewhat ſuſpect, by what I have obſerved, that this degree of heat, which our French phyſician found in the Hungarian mines, might be rather in great part from the peculiar nature of thoſe places, or of the minerals generated there, than barely (as he and thoſe, that informed him, ſuppoſe) from the greatneſs of their depth beneath the ſurface of the earth: for I know ſeveral mixtures, beſides thoſe that are common, of bodies neither of them actually hot, which

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* In the diſcourſes about *Antiperiſtaſis*, the following paſſages are taken out of a ſmall narrative, conſiſting of about two ſheets of paper of *Jo. Baptiſta Morinus*, publiſhed in the year 1619, and entitled, *Relatio de Locis Subterraneis*, annexed to a diſcourſe (too much built on Aſtrological and Ariſtotelian grounds) of the threefold region, that he conceives to be as well in the earth as in the air.

† *Unde calor ille procederet petii à præfecto? Reſpondit, ex partibus inferioribus, inferius enim perpetuo calet. Quod reſponſum magis adhuc miratus, quæſivi an res ita ſeſe haberet in fodinis omnibus? Reſpondit ita ſe habere in omnibus, ſaltem profundis, ut poſt profundum terræ frigidæ tractum, in locum calidum deſcendatur. Et quod, ubicunque terra foditur poſt ſimilem profunditatem, nullum amplius ſentitur frigus, ſed ſemper calor, quantumcunque profundè fodiatur.*

‡ ——— *Percunctatus ſum, an quo magis acceditur ad terræ centrum, calor ille major perciperetur? Reſpondit, id nunquam fuiſſe animadverſum, niſi interdum dum fodiendo occurrebant venæ calidorum mineralium.*

——— *Hæc reſponſa non in unicâ fodinâ, & ab unico præfecto accepi; ſed,* &c.

will produce a conſiderable degree of heat. And very credible eye-witneſſes affirm, that in ſome parts of *England* they dig up a good ſtore of a kind of mineral, which is thought to be of a vitriolate nature, which, by the bare addition of common water, will grow hot, almoſt to ignition. So that the Hungarian mines being deep, as appears by our author's narrative, being not deſtitute of water enough to make a ſubterraneal ſpring in the mine itſelf, beſides what water may plentifully aſcend in the forms of vapours, and moiſten the ore, it may be ſuſpected, that either the water, or ſome appropriated mineral ſpirit or juice (of which the bowels of the earth may contain divers, that we know nothing of) may produce, together with the mineral, a warm ſteam, which, for want of ſufficient vent in thoſe narrow, and cloſe places, may heat them conſiderably. Which conjecture may be countenanced by theſe three circumſtances, that I took notice of in our author's narrative; one, that the ſmoke, that copiouſly aſcended out of the mine by the perpendicular grove, was not barely hot, but conſiſted of ſtinking exhalations, which were ſo ſaline, and fretting, as oftentimes to corrode and ſpoil both the wooden ladders or ſtairs, and the iron inſtruments of the diggers. The other, that the overſeers themſelves of the mines told *Morinus* (as we lately ſaw) that they in ſome places met with veins of hot minerals, which made it hotter than the bare vicinity of thoſe places to the centre of the earth would have done. And laſtly [||], as our author was deſcending into the golden mine at *Cremnitz*, he found in one place, the heat to increaſe as he deſcended more and more, (which ſeems not to agree with a paſſage we lately mentioned out of him) and to exceed any he had met with in any other mine; and afterwards the overſeer bringing him into a room, that abounded with ſmaragdine vitriol, (the mineral, whence this heat proceeded) though the room were ſpacious, he found there, beſides a ſharp ſpirit very offenſive to his throat, ſo troubleſome a heat, that he was ready to faint away with ſweating, and very much wondered how the diggers were able to work there. And elſewhere the author himſelf notes, that ſuch hot mines of vitriol, or ſulphur, may be found even in the firſt region of the earth, (as he calls that, which is ſomewhat near the ſurface, which he thinks fit to name the *cold region)* and within a large ſphere of activity make it perpetually hot. But this, as I was intimating, I mention but as a ſuſpicion, or a conjecture; and notwithſtanding that the degree of heat may be much increaſed in theſe mines, by the concurrence of accidental cauſes, in caſe the conjecture be admitted; yet the frequency of a ſenſible degree of heat in very deep places does very little favour their opinion, that will allow the earth to have no other heat but what it receives from the ſun-beams, or by the manifeſt fire of burning hills, as *Ætna* and *Veſuvius*. And if it ſhould be objected, that this ſubterraneal heat is adventitious to the earth, which is ſupremely cold of its own nature; *Gaſſendus* might reply, that it is as likely, that the coldneſs of it near the ſuperficies may be adventitious too, and that it appears at leaſt as manifeſtly, that the one proceeds from the contiguous air, as it does, that the other proceeds from ſome included fire. And if I miſremember not, he hath this conſideration, that it is ſomewhat ſtrange, that nature ſhould have intended the earth for its *Summum Frigidum*, and yet that a greater part (and for aught we know the greateſt) ſhould be conſtantly kept warm, either by the ſun, as under the torrid zone, or by the ſubterraneal fires. But the objection mentioned againſt *Gaſſendus* oppoſes but one of the arguments we have alledged againſt the earth's being the *Primum Frigidum*, they mean not the elementary earth, but ſome body

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[||] *Cum deſcendendo calorem illam magis ac magis augeri ſentirem; hujus rationem petii à præfecto, quod in nullâ adhuc odinâ ſimilem caloris intenſionem percipiſſem. Reſpondit, mineram vitrioli paulo inferius exiſtere, quæ calorem multiplicaret.*

that is mingled with it; I ſhall deſire to know, which it is they mean, of the many other bodies, that make up the terreſtrial globe, that we may examine what right it has to that title. And in the mean time I ſhall conclude againſt them, that the earth it ſelf has none, ſince they grant a colder body than it, and ſuch a one as the earth muſt be beholden to, for the greateſt degrees of coldneſs it chances to poſſeſs.

11. BUT though, I preſume, enough has been ſaid to make it appear unlikely, that the earth ſhould be the *Primum Frigidum*, yet I muſt in this diſſent from the learned *Gaſſendus*, that he thinks the earth, not only not to be the *Primum Frigidum*, but not to be naturally cold any more than hot. For the inſenſible parts of the earth, like thoſe of other firm bodies, being heavy, and perhaps groſs, and either having no conſtant motion at all, or at leaſt a far more remiſs agitation, than that of our ſenſories; it ſeems to follow, that the earth muſt ſeem cold to us, unleſs it be, by the communicated heat, or motion of ſome extrinſick agent, put into a degree of agitation, that belongs not to its own nature. And for the like reaſon I think it not improbable, that pure earth ſhould in its own nature be colder, than either pure water, or pure air; ſince the earth being a conſiſtent body, its component particles are at reſt among themſelves, or at leaſt moved with an almoſt infinite ſlowneſs; whereas water and air being fluids, their component particles muſt be in a reſtleſs and various motion, and conſequently be leſs remote from heat, which is a ſtate, wherein the various agitation of the minute particles is more vehement.

12. AND if thoſe, that plead for the earth, had declared, that they meant not the pure or elementary earth, but that part of the terreſtrial globe, that is diſtinct from the ſea, and other waters, that make it up, and would have earth in that ſenſe not to be the *Primum Frigidum*, but only the *Summum Frigidum*, perhaps they might have a better plea for their opinion, than they can urge for theirs, who contend for the water or the air; eſpecially, if, to countenance their opinion, this memorable obſervation be added, which I have met with among thoſe navigators, that have had the greateſt experience of the frigid zone; for the Dutch, that ſailed thrice to *Nova Zembla*, and once wintered there, * affirm in their firſt voyage, that the higheſt degrees of cold are not to be met with in the main ſea, where yet men are moſt expoſed to the operations of the air, and of the water, but either upon the land or near it. That accurate geometrician and hydrographer *Fournier* tells us, that in 1595, the Hollanders being intercepted by icy ſhoals in the ſtrait of *Weigats*, and meeting with certain Muſcovites, demanded of them, whether thoſe ſeas were always frozen; and were anſwered, that neither the northern ſea, nor that of *Tartary* did ever freeze; and that it was only that ſtrait, with the ſea contiguous to the ſhores of ſome bays and gulphs, that were frozen. And our judicious author not only adds, that in effect all thoſe, that ſail into thoſe parts, relate, that all thoſe lumps of ice are ſuch as have been looſened, and ſevered from the iſlands, and the rivers of the *Samojeds* and *Tartars*, but adventures to affirm in general terms, that it is certain, the main ſeas never freeze, and that it is but the confines, and ſhores of ſome of them, that are frozen.

13. THAT the water is the *Primum Frigidum*, the opinion of *Ariſtotle* has made it to be that of the ſchools, and of the generality of philoſophers. But I can as little

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* It was not the ſea, nor the nearneſs unto the pole, but the ice about the land, that lett and hindered us (as I ſaid before); for that as ſoon as we made from the land, and put more into the ſea, although it was much farther northward, preſently we felt more warmth, and in that opinion our pilot *William Barents* died, who notwithſtanding the fearful and intolerable cold that he indured, yet he was not diſcouraged, but offered to lay wagers with divers of us, that by God's help he would bring that pretended voyage to an end, if he held his courſe north-eaſt from the north-cape. *Gerat de Veer in Purchas*, p. 474.

acquieſce in this opinion, as in the former, not finding it agreeable to what experience teaches us.

14. For not to mention, that it would be very difficult to prove, that divers very cold bodies, as gold, and ſilver, and cryſtal, and ſeveral other fuſible ſtones have in them any water at all, to which their coldneſs may with any degree of probability be aſcribed; nor to urge the arguments, that ſome modern contenders for the ſupreme coldneſs of the air are wont to imploy; not (I ſay) to inſiſt on ſuch things, I ſhall content my ſelf to make uſe of this obvious Φαινόμενον of cold, that in rivers, ponds, and other receptacles of water, the congelation begins at the top, where the liquor is expoſed to the immediate contact of the air; which ſufficiently argues, that the air is colder than the water, ſince it is able not only ſenſibly to refrigerate it, but to deprive it of its fluidity, and congeal it into ice: whereas if the water it ſelf were the *Primum Frigidum*, either it ought to be, at leaſt as to the major part of it, always congealed, or we may juſtly demand a reaſon, why, when it does freeze, the glaciation ſhould not begin in the middle, or at the bottom, as ſoon as at the top, if not ſooner. And our arguments againſt the precedency of the water in point of coldneſs may be ſtrengthened by this, that froſts are wont to be hardeſt, when the air is very clear, and freeſt from aqueous vapours; whereas in rainy weather, wherein ſuch vapours moſt abound, the cold is wont to be far more remiſs. To which we may add, what we lately delivered from the obſervation of navigators, that even in the frigid zone the main ſea, where yet the water is in the greateſt maſs, and ſo moſt likely, as well as advantaged to diſcloſe its nature, never freezes, though the ſtraits, and bays, and gulphs be frozen over; which argues, that the greateſt degrees of cold are rather to be aſſigned to the air, or to the earth, than to the water, which by the practice formerly mentioned of the maſters of the French ſalt-marſhes appears to be (when it is of a conſiderable depth) fitter to preſerve bodies from congelation, than to congeal them. Which inſtance I the rather repeat, becauſe it ſeems to argue, that the water is not ſo much as diſpoſed to receive any very intenſe degree of cold at a remote diſtance from the air. For though navigators tell us of exceeding thick pieces of ice, yet, as we have already elſewhere noted, we are not bound to believe, that the congealing cold has pierced any thing near ſo much as that thickneſs amounts to, from the ſuperficies of the ſea directly downwards: for though it were no great matter, if it did, in compariſon of that depth of the ſea, which, though the water be naturally cold, the ſharpeſt air is unable to congeal; yet we have elſewhere proved, that thoſe thick maſſes of ice are not ſolid and intire pieces, but rather heaps of many flakes, and other fragments of ice, which running upon one another, or ſliding under one another, are by the congelation of the intercepted water (and perchance half thawed ſnow) as it were, cemented together into miſhapen unwieldy maſſes: which conjecture agrees very well with that obſervation of the ingenious captain *James*, which he delivers in theſe words:

‘ It ſeldom rains after the middle of *September*, but ſnows; and that ſnow will not ‘ melt on the lands, nor ſands: at low water, when it ſnows (which it doth very ‘ often) the ſands are all covered over with it, which the half-tide carries officiouſly ‘ (twice in twenty-four hours) into the great bay, which is the common rendezvous ‘ of it. Every low water, are the ſands left clear, to gather more to the increaſe ‘ of it. Thus doth it daily gather in this manner till the latter end of *October*, and ‘ by that time hath it brought the ſea to that coldneſs, that as it ſnows, the ſnow will ‘ lie upon the water in flakes, without changing its colour, but with the wind is ‘ wrought together, and as the winter goes forward, it begins to freeze on the ſurface ‘ of it, two or three inches, or more in one night; which being carried with the half

“ tide, meets with ſome obſtacle (as it ſoon doth) and then it crumples, and ſo runs upon it ſelf, that in few hours it will be five or ſix foot thick; the half-tide ſtill flowing, carries it ſo faſt away, that by *December* it is grown to an infinite multiplication of ice.’ Thus far this navigator; to which I ſhall add another paſſage out of one of his countrymen, (Mr. *Hudſon*, famous for the northern diſcoveries, that bear his name) by which, added to what has been elſewhere delivered to the ſame purpoſe, we may be invited to believe, that the vaſt hills and iſlands of ice, that are to be met with about the ſtraits of *Weigats*, and elſewhere, are not generated of the ſea itſelf. ‘ It's no marvel (ſays he, *Purchas*, lib. 3. cap. 15. p. 579.) that there is ſo much ice in the ſea towards the pole, ſo many ſounds and rivers being in the lands of *Nova Zembla*, and *Newland* to ingender it, beſides the coaſts of *Pecora*, *Ruſſia*, *Greenland*, with *Lappia*, as by proof I find by my travel in thoſe parts.’

15. BUT for all this, I think not fit, as does the ingenious *Gaſſendus*, and ſome others, to make the water indifferent, as to heat and cold. For, as I formerly noted concerning the earth, ſo I muſt now repreſent touching the water, that, ſetting aſide the heat of the ſun, which is but adventitious, where it does operate, and which leaves many vaſt portions of that element, which it does not conſtantly reach, the inſenſible parts of water are much leſs agitated, than thoſe of our ſenſories temperately diſpoſed, and conſequently may in regard of us be judged cold. For though water being a liquor, I readily allow it a various motion of its component corpuſcles, (that being requiſite to make a body fluid) yet ſuch an agitation, which is ſufficient for fluidity, may be, and often is, far more remiſs, than that of the ſpirits, blood, and other liquors of ſo hot a ſanguineous animal as man; as we ſee, that urine, though after it has been long emitted, it continues a fluid body, yet its parts are far leſs agitated, than they were, when it came hot, and reeking out of the bladder.

16. AND upon this occaſion, I ſhall add, what by inquiry I have learned, that (except the parts ſomewhat near the ſuperficies of the water, which the heat of the ſun, or the warmth of the neighbouring lower region of the air may give ſome warmth to) the whole body of the ſea is very cold: for being very well acquainted with one, that for ſome time got a livelihood by going down into the bottom of the ſea, to fetch up what could be recovered out of ſhipwrackt veſſels, I purpoſely inquired of him, what cold he felt under water; and he more than once told me, that though near the top of the water the cold were very moderate, yet when he was neceſſitated to deſcend a great depth, he found it ſo great, that he could not very long ſupport it. And particularly he told me, that having occaſion to deſcend about twelve or fourteen fathom deep (which is nothing in compariſon of the depth of many ſeas) to faſten ropes to the ordnance of a great ſhip, that was ſome years ſince caſt away, near the coaſt of one of the northern countries; though he was not incommoded in point of reſpiration, and though he felt no other inconveniencies, that might diſſuade his tarrying longer, yet the cold was ſo great, and troubleſome, that he was not able to endure it above two or three hours, but was conſtrained to remount to a milder, as well as higher region. I wiſhed ſeveral times he had had with him a weather glaſs (for ordinary thermometers would on that occaſion have been unſerviceable) to prevent ſome little doubt, that might be made, whether the intenſe cold he felt might not be only and chiefly in reference to his body, which might be ſo altered, and diſpoſed by this new briny ambient, as to make ſuch a diſturbance in the courſe or texture of his blood, as that, which makes aguiſh perſons ſo cold at the beginning of the fit, though the temperature of the ambient body continue the ſame. But this

is not the only perſon, that found the ſea exceeding cold; for I remember *Beguinus* relates from the mouth of a Marſeillian knight, that was overſeer of the coral-fiſhing in the kingdom of *Tunis*, that having upon that coaſt let down a young man, to feel whether coral were hard or ſoft, as it grew in the water, when this man was come about eight fathom, near the bottom of the ſea, he felt it exceeding cold. To which we ſhall add the teſtimony of a ſober traveller *Joſephus Acoſta*, who tells us, 'That it is a thing remarkable, that in depth of the ocean, the water cannot be made hot by the violence of the ſun, as in rivers: finally (he ſubjoins) even as ſalt-petre (though it be of the nature of ſalt) hath the property to cool water, even ſo we ſee by experience, that in ſome parts and havens, the ſalt water doth refreſh: the which we have obſerved in that of *Callao*, where they put the water or wine, which they drink, into the ſea in flaggons to be refreſhed: whereby we may undoubtedly find, that the ocean hath this property, to temper and moderate the exceſſive heat.' For this cauſe we feel greater heat at land than at ſea, *cæteris paribus*, and commonly countries lying near the ſea are cooler than thoſe that are farther off. By all theſe teſtimonies, it ſeems to appear, that both in very cold regions, and very hot, the deep parts of the ſea ſeem to be very cold, the ſun-beams being not able to penetrate the ſea to any great depth: for I remember, that having enquired of the diver I lately mentioned, whether he could diſcern the light of the ſun at any great diſtance from the ſurface of the water, he anſwered me, that he could not; but as he went down deeper and deeper, ſo he found it darker and darker, and that to a degree, that would ſcarce have been expected in ſo diaphanous a body as water is.

**Beguinus in Tyrocinio Chymico, lib. 2. c. 1.**

**Joſephus Acoſta lib. 2. cap. 11.**

17. But this ſubmarine cold (if I may ſo call it) though it be great and conſiderable, is not ſo intenſe, as to intitle water to be the *Primum Frigidum*; ſince as cold as our divers found it at the bottom of the ſea, they did not find it cold enough to freeze the water, as the air often does at the top.

18. The next opinion, we are to conſider, is that of the Stoicks of old, and adopted by the generality of modern philoſophers, that are not Peripateticks, who aſſert the air to be the *Primum Frigidum*: but being ere long more particularly to treat of the temperature of the air, we will reſerve till then to examine, whether it be cold of its own nature or not; but in the mean time, we ſhall here take leave to queſtion, whether it ought to be eſteemed the *Primum Frigidum*. For not to mention, that *Ariſtotle*, and the ſchools, with many other learned men, think the air ſo far from being the coldeſt of the elements, that they reckon it among the hot ones, becauſe I confeſs their opinion is not mine, not to repreſent the heat of the air in the torrid zone, nor that by the generality of philoſophers, the upper region of the air, which is believed to make incomparably the greateſt part of it, is always hot, and the lower region is ſo too, in compariſon of the middle, though the coldneſs even of this is not perhaps unqueſtionable; not to urge any of theſe things, I ſay, I ſhall in this place mention only two obſervations.

19. The one is that, which I lately recited, touching the great coldneſs of the water in the deeper parts of the ſea; for it is not eaſy to ſhew, how this great cold proceeds from that of the air, whoſe operation ſeems not (as may be judged by that little way that froſts pierce into the moiſt earth) to reach very far beneath the ſurface of the water, (inſomuch that captain *James*, who had very good opportunity to try, allows not, in caſe the ice be not made by accumulation, that the froſt pierces above two yards perpendicularly downwards from the ſurface of the water, even in the coldeſt habitable regions.) And this will ſeem the more rational, if we conſider, that in caſe the coldneſs of the ſea proceeded conſtantly from the air, as ſuch,

the cold would be greater near the ſurface, where it is contiguous to the air, than in the parts remoter from it; and yet the contrary may appear by the paſſages lately recited.

20. BUT if it be objected, that this at beſt can prove no more, than that the air is not the *Primum Frigidum*; notwithſtanding which, it may be the *Summum Frigidum*. For anſwer, I muſt proceed to my ſecond argument, which will perhaps evince, that it is not that neither; for by the ſame way of arguing, by which thoſe, I am now dealing with, endeavour to prove the air to be the coldeſt body in the world, I ſhall endeavour to prove, that it is not ſo: for their grand, and (as far as I remember) their only conſiderable argument is drawn from experience, which ſhews, that water begins to freeze at the top, where it is expoſed to the air. But to this vulgar experiment I oppoſe that of mine, which I have often mentioned already to other purpoſes, that by an application of ſalt and ſnow, I can make water, that would elſe freeze at the top, begin to freeze at the bottom, or at any ſide I pleaſe, and that much ſooner than the common air, even in a ſharp froſty night, would be able to congeal it: and when in exceeding cold weather the ambient nocturnal air had reduced a parcel of air, purpoſely included in a convenient glaſs, to as great a degree of condenſation as it could; I have more than once, by the external application of other things, been able to condenſe it much farther: which argues, that it is not the air as ſuch, but ſome adventitious frigorifick corpuſcles (taking that term, as I do in this treatiſe, in a large ſenſe) that may ſometimes be mingled with it, which produce the notableſt degrees of cold, or upon whoſe account the air produces them. And if theſe be duly applied, water will be congealed, whether air comes to touch the ſurface of it or no; nay, though bodies, which the air can never penetrate, or congeal any of their parts, be interpoſed, as may appear by the experiments formerly mentioned of freezing water included in glaſs bubbles, and ſuſpended in oil of turpentine, and other uncongealed liquors; and it is worth taking notice of by them, that conclude the air's being the *Primum Frigidum*, from the water's beginning to freeze at the top, where it is contiguous to the air, that it is there alſo, where the ice begins to thaw.

21. BESIDES the three opinions we have hitherto examined, there is a fourth, that juſtly deſerves to be ſeriouſly conſidered; for the learned and ingenious *Gaſſendus* is ſuppoſed, though I doubt how truly, to be the author of it; and though, according to his cuſtom, he ſpeaks warily, and not ſo confidently of it, yet in his laſt writings he much countenances it; yet ſome eminently learned men, as well of our own, as of other nations, have reſolutely enough embraced it. According then to theſe, the congelation of liquors, and the cold we meet with in the air, water, and other bodies, proceeds from the admixture of nitrous exhalations, or corpuſcles introduced into them: and as I have a great reſpect for divers of theſe men's perſons, ſo I like very well, in their opinion, that they do not aſcribe the ſupreme degree of frigefactive virtue to the air itſelf, but to ſome adventitious thing, that is mingled with it: but whereas they pitched upon nitre, as the grand univerſal efficient of cold, I confeſs I cannot yet fully acquieſce in that tenet. For though I am not averſe from allowing ſalt-petre to be one of thoſe bodies, that are endued with a refrigerating power, and to be copiouſly enough diſperſed through ſeveral portions of the earth; yet, for aught I know, there may be not only divers other cauſes of cold, but divers other bodies qualified to be efficients of cold, as well as ſalt-petre.

22. AND firſt, if cold be not a poſitive quality, but the abſence of heat, the removing of calorifick agents will in many caſes ſuffice to produce cold; without the introduction of any nitrous particles into the body to be refrigerated. But

becauſe it is diſputable, whether cold be a poſitive quality or no, we will urge this argument no further, till the controverſy be decided; and till then, as it will remain not improbable, we propoſe it as no other, but proceed to the next.

23. In the ſecond place, I ſee not as yet any proof, that the great cold, we have formerly mentioned to be met with in the depths of that vaſt body, the ſea, eſpecially when it is greater elſewhere than nearer the top, where the air may better communicate its coldneſs to it, muſt be the effect of nitrous atoms, which muſt certainly ſwarm in prodigious multitudes, to be able to refrigerate every drop and ſingle particle of ſo ſtupendouſly vaſt a body as the ocean. Beſides that I remember not to have found or known it obſerved, that nitre, eſpecially in vaſt quantities, reaches near ſo deep in the earth, as thoſe parts of the ſea, that are found exceeding cold. And as the halituous part of nitre is more diſpoſed to fly up into the air, than drive down into the ſea; ſo we find no great documents of its having its groſſer and ſenſible parts abounding in the ſea-water, ſince the evaporations of that leaves not behind it ſalt-petre, but common ſalt. But theſe, though no light conſiderations, are not thoſe, that moſt weigh with me.

24. For, in the next place, I am not ſatisfied with the experiences I find alledged to prove, that it is by nitre, that the air and the neighbouring parts of the earth, and water (not to repeat the objections I lately borrowed from the ſea) receive their higheſt degrees of cold. For when *Gaſſendus* and others tell us, that it is nitre reſolved into exhalations, that makes the gelid wind, which refrigerates all things it touches, and penetrating into the water, congeals it; this, I ſay, to me will ſeem precarious, until *Gaſſendus* (or ſome other for him) tells us, what experiments they are (which he ſeems in one place to intimate) that this new doctrine depends on: for I confeſs, that for my part, I, who have perhaps had more opportunity to reſolve nitre, have ſeen no great feats, that the ſteams of it have done, more than thoſe of other ſaline bodies, in the production of cold; and the ſpirit of nitre, which is a liquor conſiſting of the volatile parts of that reſolved ſalt, not only does not (that I have obſerved) appear to the touch to have conſiderably, if at all, a greater actual cold, than that of divers other liquors, but ſeems to have a potential heat. For whether or no the exhalations of nitre be able to congeal water into ice, I have formerly obſerved, that the ſpirit of nitre or aqua fortis will diſſolve ice into water, very near, if not altogether as ſoon as the ſpirit of wine it ſelf; which inflammable liquor is generally acknowledged to be in a high degree potentially hot. If *Gaſſendus* did not mean ſuch ſteams of ſalt-petre as theſe, which I have been ſpeaking of, it had not been amiſs to have ſignified, what other kind of corpuſcles of reſolved nitre he meant, without leaving his reader to divine it: and if we may judge of other experiments, which we lately took notice, that *Gaſſendus*[*] ſeems to intimate by that, which he ſets down a little after, compared with that he had mentioned a little before; I am not likely much to be convinced by them, but ſhall rather be tempted to ſuſpect, that learned man might be impoſed upon by others to write that, as matter of fact, which he never had tried, and yet own not the having it by report. For whereas he ſeems to ſay, that diſſolved nitre mingling itſelf with water, freezes it, and that in ſummer; yet I muſt freely profeſs, that

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[*] *Gaſſendi* Phyſ. Lib. 6. Sect. 1. pag. 399. *De qualitatibus rerum —— ac addi quidem fortaſſis poteſt, præcipua frigoris ſemina, ſi quæ conſtant, potiſſimum ex frigorificis atomis abire in halinitrum corporaque ipſis affinia, quando experimur non exſolvi halinitrum, quin et penetrando in aquam, ipſam congelet, et univerſa a ſe contacta refrigeret, et abeundo in halitum creet gelidum ſeu frigidum ventum, ſed res pendet ex variis, quæ non poſſunt hoc loco commemorari, experimentis.*

although ſome other learned moderns teach the ſame thing (but without any man's avouching it, that I know, upon his own experience) I, who am no ſtranger to nitrous experiments, have never been able to produce, or ſo fortunate, as to ſee any ſuch effect: and it is ſomewhat ſtrange to me, that chymiſts, who make ſuch frequent ſolutions of nitre, and oftentimes with leſs water than is ſufficient to diſſolve it all, ſo that by conſequence the proportion of the nitre to the water muſt have run through almoſt all the poſſible meaſures of proportion, ſhould never ſo much as by chance (as I can hear) have obſerved any ſuch matter. And that, which makes me thus interpret *Gaſſendus* his meaning, (though in one of the two paſſages, wherein he ſets down this experiment, he mentions alſo ſnow, or ice, to be added to the nitre) is, that in the firſt of thoſe two paſſages, he aſcribes the congelation to nitre alone, without ſpeaking of either ice or ſnow; and in the other place, not only his words ſeem to import [†], that notwithſtanding the addition of the other ingredients, the corpuſcles of the nitre expiring out of the mixture, and penetrating into the water, are they, that make it freeze; but the exigence of his diſcourſe ſeems to require ſuch an interpretation: for to ſay, it is the corpuſcles of the nitre, that were harboured in the ice or ſnow, that freeze the water they invade, is no better than to beg the queſtion. For beſides that he ought to prove, that there are multitudes of the corpuſcles of nitre lodged in ſnow and ice; beſides this, I ſay, ſince theſe two bodies are ſaid to be water, before they were congealed, to grant what his explication ſuppoſes about ice and ſnow, is to grant in effect, that nitre alone (without ice or ſnow) can turn water into ice, which is the thing, that experience warranted us lately to deny. And if this be all, that is meant by the experiment, the mixing of nitre with the ice, or the ſnow, will ſignify very little, to evince what ſhould be proved. For, if inſtead of nitre you take ſea-ſalt, or the ſpirit of ſalt, nay, the inflammable part of wine, the experiment will ſucceed; and yet I think *Gaſſendus* would not have the corpuſcles of theſe bodies to be frigorifick, like thoſe of nitre; which yet they may be proved to be by the ſame argument, which is imployed to ſhew, that the corpuſcles of the nitre, which is added as a diſtinct ingredient to the ice, or to the ſnow, are the efficients of the congelation.

25. HAVING thus examined *Gaſſendus* his experiments, we will now, as our next and laſt argument touching this ſubject, ſubjoin our own, as far as we can find any of them among our notes; ſome of which follow in theſe words:

26. [AS cold as they think ſalt-petre to be, who teach its ſpirituous parts to be the grand and catholick efficients of cold, yet we found, that it would diſſolve ice readily enough, as well as ſea-ſalt, *&c.* are wont to do, as we collected from this, that roch'd petre mingled with ice would freeze the vapours wandering in the air to the outſide of the ſingle phial, wherein we made the experiment, which the ice alone would not have done; and having placed ſome groſſer beaten nitre (of the ſame parcel) in little heaps here and there upon plates of ice, we manifeſtly found them to ſink into the ice, which argued their diſſolving it; and having put ſome of it upon a thick and ſmooth piece of ice, we found, that it had pierced a hole quite through it, whilſt the ſurrounding part of the ice remained of a good thickneſs.]

27. [WE took a large ſingle phial, almoſt full of water, and put it into as much roch'd petre, as by keeping it a good while by the fire's ſide, we could diſſolve in it; of which one mark was, that there remained a pretty deal of ſalt intire at the bottom

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[†] b. pag. 400. *Quomodo poſſunt corpuſcula nitri in aquam infuſi illam præter modum adeo frigidam reddere, imò et per æſtatem etiam congelare, dum nitrum nivi glacieive detritæ commiſtum lagenæ circumponitur, ipſæque præter corpus lagenæ penetrant in aquam contentam.*

of the liquor: this being expoſed to the air, during an extremely ſharp night, and a good part of the day, the ſolution was frozen ſo hard to the very top of the liquor, that having broken the glaſs, we could hardly break the included maſs. But at the bottom there appeared ſome liquor, with cryſtals of nitre well figured, that ſeemed to have ſhot in it, and argued the water to be ſufficiently impregnated with the ſalt.]

28. [As for the ſpirituous parts of nitre, ſo far forth as their temper, as to heat or cold, can be judged by diſtillation, and by weather-glaſſes, they are not actually more cold than ſome other liquors, and appear rather to be potentially hot, than cold; at leaſt, they ſeem indiſpoſed to turn water into ice, ſince we have tried, that the ſpirit of nitre will readily enough turn ice into water.]

29. These three foregoing notes ſhew, that ſalt-petre is no ſuch wonderfully cold body, but that there are others colder, as being able to freeze water, which nitre could not congeal. Nay, they manifeſt, that nitre, which is ſaid to be the efficient of ice, does thaw and diſſolve it, and ſo ſeems, at leaſt in reference to it, to be rather hot than cold.

30. I ſhall add now one note more, to ſhew it does not always make water ſo much as equally cold with the common air; the experiment I find thus recorded.

31. [We took a ſealed weather-glaſs, and by a little pulley faſtened to a frame, ſuſpended it in a ſolution of roch'd petre, as ſtrong as we could make it, without heat; as appeared by a pretty quantity of nitre, that had continued ſome days undiſſolved in the veſſel, which was a beer-glaſs, with a flat bottom. After the ball of the weather-glaſs had been ſuſpended in this liquor, to try, whether the ambient air were not at this time colder than the liquor, (it being a cloudy and windy day, and betwixt the hours of 11 and 12) though both the weather-glaſs and it had ſtood ſome days in the place; I lifted up the glaſs out of the water by the ſtring it hung by, that I might not touch it with my warm hands, and found the liquor in the glaſs to deſcend by degrees, about two diviſions, (which were eighths of an inch) and then by the ſtring lifting up the weather-glaſs, and putting again the ſolution of nitre under it, the included liquor was impelled up again two diviſions, and ſometimes two diviſions and a half: for to ſatisfy my ſelf the more fully, I repeated the experiment ſeveral times, and obſerved, that the included liquor uſually aſcended the firſt diviſion ſo faſt, that the eye could perceive its progreſs, and that the aſcent upon the immerſion in the diſſolved nitre was diſcernibly quicker than the deſcent, upon the removal of the weather-glaſs into the open air, though the ſpace both of the one and of the other were about, either two diviſions, or two diviſions and a half.]

32. If it be here demanded, what then I think of the frigifactive virtue of nitre, I muſt anſwer, that I have not yet fully ſatisfied my ſelf concerning it: but thus much I am not willing to deny, that among divers other bodies, that upon ſeveral occaſions exhale from the terreſtrial globe, thoſe corpuſcles, that are of a nitrous nature, may be for the moſt part well qualified to refrigerate the air. And I am not indiſpoſed to think, that there may be ſtore of little ſaline bodies of kin to nitre, that (eſpecially at certain times) rove in great multitudes to and fro, in ſome parts of the atmoſphere; but that this aërial ſalt, which ſome moderns call volatile nitre, ſhould be true and perfect ſalt-petre, is more than I am ſure of, and that this ſalt alone ſhould be the *Summum Frigidum*, is more than as yet I am convinced of; eſpecially, ſince, for aught I know, there may be in the bowels of the earth, (whence I have ſeen many concretes digged out, whoſe very names and outſides are for the moſt part unknown, even to chymiſts themſelves) divers other bodies beſides ſalt-petere, whoſe ſteams may have a power of refrigerating the air, as great in proportion to their quantity, as thoſe of ſalt-petre. And ſince common ſalt in artificial glaciations is found to co-operate

as powerfully as ſalt-petre itſelf; and ſince it is undeniably a body, of which there is a vaſt quantity in the terreſtrial globe, and which by reaſon of the ſea, where it abounds, is exceedingly diffuſed; I ſee no great reaſon, why we may not as well eſteem that kind of ſalt among the catholick efficients of cold, and the rather, becauſe that the ſmalleſt corpuſcles our eye diſcerns of ſea-ſalt, are wont to be (though not exactly) of a cubical figure: which is that figure, *Philoponus* informs us, the great *Democritus* of old (juſtly admired by *Gaſſendus*) aſſigned to the atoms of cold: whereas, according to *Gaſſendus* himſelf, the corpuſcles of nitre, at leaſt as far as ſenſe has informed us, are not the moſt conveniently ſhaped to produce cold, ſince he labours to ſhew, that the figure of frigorifick atoms is to be tetrahedrical or pyramidal: whereas the cryſtals, or grains, great or ſmall, into which good ſalt-petre ſhoots, are wont to be priſmatical, having their baſe ſexangular. But to return to what I was ſaying concerning the congealing of water with ice, I ſhall ſubjoin, that the ſame experiment countenances my conjecturing, that oftentimes it may not be emanations of one ſalt, or other body, but a peculiar and lucky conjunction of thoſe of two or more ſorts of them, that produces the intenſe degree of cold; as we ſee, that ice and ſnow themſelves have their coldneſs advanced (as to its effects) by the mixture either of ſea-ſalt or nitre, or ſpirit of wine, or any other appropriated additaments. Nay, I may elſewhere have occaſion to ſhew, that actual cold may be manifeſtly promoted, if not generated, by the addition of a body, that is not actually cold. But to all this I muſt add, that I doubt, whether any of thoſe ſaline or terreſtrial expirations, either ſingle or conjoined, be the adequate cauſes of cold; ſince, for aught I know, there may be other ways of producing it beſides the introduction of frigorifick, whether atoms or corpuſcles, of which we may have occaſion to take ſome notice hereafter. In the mean time, having diſcourſed thus long againſt the admitting a *Primum Frigidum*, I think it not amiſs to take notice once more, that my deſign in playing the ſceptick on this ſubject, is not ſo much to reject other men's probable opinions of a *Primum Frigidum*, as abſolutely falſe, as it is to give an account, why I look upon them, as doubtful.

## TITLE XVIII.

### *Experiments and obſervations touching the coldneſs and temperature of the air.*

1. I HAVE ſhewn in the former ſection, that the air is not the *Primum Frigidum*; but yet I cannot readily yield my aſſent to the opinion of the learned *Gaſſendus*, and ſome others, (who have written before and ſince him) that the air is of itſelf indifferent; that is, neither cold, nor hot, but as it happens to be made either the one or the other by external agents. For if we take cold in the obvious and received acceptation of the word, that is, for a quality relative to the ſenſes of a man, whoſe organs are in a good or middle temper, in reference to cold and heat; I am hitherto inclinable to think, that we may rather attribute coldneſs to the air, than either heat, or a perfect neutrality as to heat and cold. For to make a body cold as to ſenſe, it ſeems to be ſufficient, that its minute corpuſcles do leſs agitate the ſmall parts of our organs of feeling, than they are wont to be agitated by the blood, or other fluid parts of the body; and conſequently, if ſuppoſing the air devoid of thoſe calorifick and frigorifick atoms, to which the learned men, I was naming, aſcribe its heat and cold, it would conſtitute a fluid, which either by reaſon of the minuteneſs of its parts, or their want of a ſufficiently vehement motion, would leſs affect the ſenſory of feeling, than the internal liquors and ſpirits of the body are wont to do, and ſo it would appear actually cold. Nor is it neceſſary, that all liquors, much leſs all fluids,

ſhould be as much agitated as the blood and vital humours of a human body, as we ſee (to omit what in the laſt ſection is mentioned about newly emitted urine, and to ſkip other obvious inſtances) in thoſe fiſhes and other animals, whoſe blood and analogous juices are always, and that in the ſtate, which paſſes for their natural ſtate, actually cold to our touch. And I ſee no ſufficient reaſon, why we ſhould not conceive the air even in its natural ſtate, (at leaſt as far forth as it can be ſaid to have a natural ſtate) to be one of the number of cold fluids. For as to the main, if not only, argument of *Gaſſendus*, and others, namely, that as we ſee the air to be eaſily heated by the action of the ſun, or the fire, ſo we ſee it as eaſily refrigerated by ice, and ſnow, and northerly winds, and other efficients of cold, and that heat and cold reign in it by turns in ſummer and in winter; this only proves, what I readily grant, that the air is eaſily ſuſceptible at ſeveral times of both theſe contrary qualities; but it does not ſhew, that one is not more connatural to it than the other; as we ſee, that the water may be eaſily deprived of its fluidity by the circumpoſition of ſnow and ſalt, and reduced to be fluid again by the ſun, or the fire; and yet, according to them, as well as to others, fluidity, not firmneſs, is the natural quality of water. But this is not that, which I lay moſt weight upon; for I conſidered, that it is manifeſt, and acknowledged by theſe learned men themſelves, that the heat of the air is adventitious to it, and communicated by the beams of the ſun, or of the fire, or by ſome other agents naturally productive of heat, as well in other bodies as the air. And it is alſo evident, that upon the bare abſence (for aught elſe, that appears) of the ſun, or extinction of the fire, or removal of the other cauſes of heat, the air will, as it were, of its own accord, be reduced to coldneſs. Whereas, that there are ſwarms of frigorific atoms diffuſed through the air, from which all its coldneſs proceeds, is but an hypotheſis of their own, far from being manifeſt in itſelf, and not hitherto, that I know of, proved by any fit experiment, or cogent reaſon. And though in ſome caſes I am not adverſe to the admitting ſuch corpuſcles, as may in a ſenſe be ſtyled frigorific, yet I ſee not, why we ſhould have recourſe to them in caſes, where ſuch a bare ceſſation, or leſſening of former motion, as may eaſily be aſcribed to manifeſt cauſes, may ſerve the turn, as to a *ſenſible* (for I now conſider not the cauſes of the *intenſer*) coldneſs in the air, without taking them in. And the opinion, I incline to, has at leaſt this advantage, that the air ſeems to be as rightfully termed cold, as iron, marble, mercury, cryſtal, ſalt-petre, and ſuch other bodies, which men unanimouſly look upon as ſuch; there being none of theſe, to which the argument imployed againſt the coldneſs of the air, is not applicable, ſave that the air being a fluid of a looſer and finer texture, does ſooner receive and loſe the impreſſions of heat and cold. And yet if a block of marble, for inſtance, or an iron bullet, were removed into one of thoſe empty ſpaces, that *Gaſſendus*, and ſome others, ſuppoſed to be beyond the bounds of this world, I ſee not, why it ſhould not be rather cold, than either warm, or in a ſtate of perfect neutrality; ſince when the corpuſcles of heat and thoſe of cold had extricated themſelves, and were flown away into the neighbouring vacuum, the component particles of the ſtone or metal, whoſe implicated texture would hinder their diſſilition, remaining much leſs agitated than our organs of feeling are by the warm blood and ſpirits, that vivify them, muſt, if applied to thoſe ſenſories, appear cold.

2. I SHALL not, upon this ſubject, ſpend any farther diſcourſe, ſince perhaps the diſpute either may be, or at leaſt may eaſily be made verbal; for in caſe thoſe I argue with, ſhould ſo explain their opinion, as not to deny, that in its own nature the air, left to itſelf, may be reputed cold in reference to the ſenſories of men, who are warm animals; but ſay, that nevertheleſs, comparing it indefinitely to other than human

bodies here below, it is ſo eaſily ſuſceptible of both the contrary qualities, that neither of them ſeems predominant in it, and that when it is conſiderably either cold or hot, it is made ſo by adventitious agents; I ſhall not much contend with them, eſpecially if it can clearly be made out, that there are great quantities of ſuch cold ſpirits, as *Cabæus* and *Gaſſendus* ſuppoſed to be univerſally productive of cold (more or leſs) in all bodies, where they get admiſſion: but of theſe cold ſpirits more perhaps elſewhere; our principal buſineſs in this ſection being to deliver experiments and obſervations; and becauſe we ſhall mention but few of the former ſort, we will diſpatch them firſt.

[3. *November* the 20th, 1662, we took a weather-glaſs, filled to a convenient height, with well-rectified ſpirit of wine, and hermetically ſealed: this we incloſed in a glaſs receiver of a cylindrical form, of about two inches diameter, and about a foot and a half high, and having cemented on the receiver, we let it alone for ſome hours, that it might be perfectly cool. Then drawing out the air, and watching it narrowly, we obſerved, that the liquor in the weather-glaſs deſcended a little, though but a very little, upon the firſt exſuction of the air, and a little, though it ſeemed ſomewhat leſs, upon the ſecond; but afterwards we did not find it ſenſibly to deſcend. This ſubſidence of the liquor, in all amounting to about the length of a barley-corn, we attributed to the ſtretching of the glaſs by the ſpring of the included air, when the ambient was withdrawn; and accordingly, upon our allowing a regreſs to the excluded air, we ſaw the ſpirit in the thermometer riſe about half a barley-corn's length to the place, whence it began to ſubſide. Afterwards we ſucked out, and let in the air of the receiver, as before, with like ſucceſs, as to the deſcent and remounting of the liquor.

4. *N. B.* WE tried with a very hot handkerchief applied to a convenient place on the outſide of the receiver, whether the included weather-glaſs would receive impreſſions from it, the air, that was wont to be intermediate, being removed: but we did not find the liquor in the weather-glaſs ſenſibly to ſwell, either by this way, or by caſting upon it the concentrated beams of a candle trajected through a double convex-glaſs. But when the air was re-admitted into the cavity of the receiver, then the ſame handkerchief, heated afreſh, and applied, made the ſpirit of wine ſenſibly, though but little more, to aſcend: of which, yet it ſeemed ſomething difficult, by reaſon of the nicety of the experiment, to eſtimate with any thing of certainty the cauſe.] So that upon the whole matter, till the experiment be repeated in air of differing tempers, to verify, whether it was the withdrawing of the wonted preſſure, or the receſs of the ſubſtance of the air, that made the liquor included in the thermoſcope ſubſide, and till the experiment be repeated with the further obſervation of other circumſtances, (which reiteration of the trial we intended, but were by intervening accidents hindered) the recited experiments will not afford much more than good hints towards the diſcovery of the temperature of the air.

I HAVE elſewhere * taken notice, that air, included in veſſels ſufficiently ſtrong and well cloſed, was not ſenſibly or at leaſt conſiderably condenſed by cold; but when the air was not ſo included, as not to be in ſome part or other expoſed to the preſſure of the outward air or atmoſphere, it would then by a degree of cold, capable to freeze water, be manifeſtly reduced into a leſs room. But how much this contraction or condenſation of the air may amount to, I did not there ſubjoin, nor has the meaſuring of it been, that I know of, attempted by any man. Wherefore we thought fit to endeavour ſomething in this kind, of which we ſhall annex a brief account, whereby it will appear upon the whole matter, that in the climate we

* In the third preliminary diſcourſe.

live in, the cold does not ſo conſiderably condenſe the air, as moſt men ſeem to have hitherto imagined.

6. And firſt, it will not be amiſs to intimate, that among other ways we tried to meaſure the ſhrinking of the air by ſealing it up in glaſſes furniſhed with long and very ſlender ſtems, that by breaking off the tips of thoſe glaſſes immerſed under water, when by the cold air of a froſty night, or the circumpoſition of ſnow and ſalt, the included air was highly refrigerated, the water might (by the preſſure of the atmoſphere upon it) be impelled into the cylindrical cavity of the broken glaſs, and by its greater or leſſer aſcent therein ſhew, how much the internal air had been made to ſhrink upon the account of the cold. But this way, for reaſons too long to be here deduced, we found troubleſome and difficult to practiſe with any thing of certainty. Nor did we ever, that I remember, by this way, bring the refrigerated air to loſe above a 30th part of its former dimenſions.

7. We would have tried alſo to meaſure the condenſation of the air by the aſcent of water into the ſtem of a bolt-head, ſo invented, that the orifice of the ſtem might be under the ſurface of the water, and the bolt-head kept erected. But this way we diſapproved, becauſe it was likely (and indeed we found it ſo by experience) that the external air would firſt freeze the uppermoſt part of the water contained in the ſtem, and thereby hinder its aſcent, and perhaps occaſion the burſting of the lower part of the ſaid ſtem.

8. Wherefore, though for want of a ſufficient quantity of ſome liquor, that would neither freeze like water, and aqueous bodies, nor congeal like common oil, and the like unctuous juices, we found it for a while ſomewhat difficult to practiſe the experiment; yet bethinking ourſelves of the indiſpoſition, that brine has to congelation, we made ſo ſtrong a brine with common ſalt, that with it (and, as I remember, with oil of turpentine alſo, of which we chanced to have ſome quantity by us) we made divers trials, of which I had two among our collections, which we ſhall here ſubjoin; whereof the one informs us, that an egg being inverted into ſalt water, the cold of a froſty night made the air ſhrink in the pipe near five inches; and the other (which is the accurateſt I meet with among my collections) gives me this account, that *January* the 29th, the air extending into 2057 ſpaces, was by the cold of the ſharp and froſty night contracted into 1965 ſpaces; ſo that in extraordinary cold weather, the moſt we could make the air loſe of its former dimenſions by the additional cold of the atmoſphere, was a twenty-ſecond part, and a little more than a third. And this was the greateſt condenſation of the air, that we remember ourſelves to have obſerved, though we were ſo careful, as after we had placed marks, where the incongealable liquor reached into the pipe, that when the internal air was expoſed abroad to the cold, we cauſed ſervants to watch, and from time to time to take notice (by placing marks) of the various aſcents of the liquor, eſpecially early in the morning, leſt we ſhould omit taking notice of the greateſt contraction of the air; which omiſſion (by reaſon that the coldneſs of the ambient air does oftentimes begin to be remitted before we can feel it to be ſo) is not eaſily avoided without watchfulneſs.

9. But having thus obſerved the condenſation of included air by the natural and unaſſiſted cold of the external air, we thought fit to proſecute the trial ſomewhat further; and in regard we conceived the cold of a mixture of ſnow and ſalt to be far more intenſe, than that of the meer ambient air alone, we endeavoured to meaſure, as near as we could, how much the one exceeded the other. And though we found, that by proſecuting the lately mentioned trial in the glaſs-egg, by the application of ice and ſalt to the elliptical part of the veſſel, the liquor riſe by our eſtimate near four

inches more (than thoſe five, which it had riſen already, upon the account of the refrigeration of the included air by the bare cold of the external) yet by proſecuting the other experiment (made the 29th of *January)* at the ſame time, when we were making it, we did ſomewhat more accurately determine the matter. For by applying ice and ſalt to the outſide of the veſſel, we found, that the included air was contracted from 1965 ſpaces, to which the cold of the ambient air had reduced it, into 1860 ſpaces; ſo that the circumpoſition of ice and ſalt did as much, nay ſomewhat more, condenſe it, after the meer cold of the external air had contracted it as far as it could, than the bare, though intenſe, cold of the ambient air could condenſe it at firſt; and the greateſt degree of adventitious cold we were able to give, by the help of nature and art, did not make the air expoſed to it loſe a full tenth part of its former dimenſions. On which occaſion it may not be unworthy obſervation, that there is no greater diſparity betwixt the proportion, in which the cold was able to condenſe the air, and that, wherein the cold was able to expand water.

10. THIS is all that at preſent I think fit to ſay, concerning the intereſt, that winds may have in the temperature of the air. And therefore I will now proceed to thoſe other particulars, wherewith I not long ſince ſaid, that I intended to cloſe up this ſection; and I might on this occaſion ſubjoin many things, but partly haſte, and partly other conſiderations will confine me to thoſe, that relate to the effects of cold upon the air in a more general way.

11. AND firſt, we will obſerve, that cold may hinder, in an almoſt incredible meaſure, the warming operation of the ſun upon the air, not only in the hotteſt part of the day (for that may ſometimes happen, even in our climate) but at ſeveral times of the day, even in the heat of ſummer.

12. I REMEMBER I once accidentally met with an intelligent and ſober gentleman, who had ſeveral times ſailed upon the frigid zone, and though an intervening accident ſeparated us ſo ſuddenly, that I had not opportunity to obtain from him the reſolution of above two or three queſtions; yet this I learned of him belonging to our preſent purpoſe, that by the help of a journal he kept, he called to mind, that upon the coaſt of *Greenland* he had obſerved it to ſnow all midſummer night; which affirmation of ſo credible a perſon imboldens me to add ſome other relations, which I ſhould elſe have ſcrupled at.

13. MR. *Logan*, an Engliſh merchant, that wintered at *Pecora*, one of the northern towns of *Muſcovy*, relates, that being there at a great ſalmon-fiſhing, there happened about the cloſe of *Auguſt* (which in many countries is wont to be the hotteſt time of all the year) ſo ſtrong a froſt, which laſted till the fourth day, *Purchas*, *lib.* 4. *pag.* 542. ‘ That the *Ozera* was frozen over, and the ice driving in the river to and ‘ again, broke all the nets; ſo they got no ſalmon, no not ſo much as for their ‘ own victuals.’

Theſe voyages are extant in Purchas, lib. 1. cap. 13. and this paſſage is in pag. 560.

14. CAPTAIN *G. Weymouth* mentions, that in *July*, though he was not near the latitude of *Nova Zembla*, much leſs of *Greenland*, yet ſailing in a thick fog, when by reaſon of the darkneſs it occaſioned, *Purchas*, *pag.* 811. ‘ he thought good to take ‘ in ſome of his ſails; when his men came to hand them, they found their ſails, ‘ ropes, and tacklings ſo hard frozen, that it did (ſays he) ſeem very ſtrange unto us, ‘ being in the chiefeſt time of ſummer.

15. IN the fifth voyage of the Engliſh to *Cherry Iſland*, which lies betwixt 74 and 75 degrees of latitude, they obſerved, that the wind being at North-eaſt upon the 24th of *July*, ‘ it froze ſo hard, that the ice did hang on their clothes.’ And in the ſeventh voyage (which was made three years after) to the ſame iſland, they mention,

*Purchas, pag.* 564. that on the 14th of *July*, ‘ the wind being northerly, they had both ſnow and froſt.’

16. THE next thing, that we ſhall take notice of, is the degree of cold, which the efficient cauſes of that quality, whatever they be, are able to produce in the air; but of this we muſt not here treat indefinitely, the ſtrange effects of cold upon other bodies being moſt of them produced by the intervention of the cold firſt diffuſed in the air, and thoſe are treated of in a diſtinct ſection: wherefore we ſhall now give two or three inſtances of the ſudden operations of the cold harboured in the air.

THE formerly mentioned Engliſh ambaſſador into *Ruſſia*, Dr. *Fletcher*, gives us two inſtances very memorable to our preſent purpoſe: *Purchas, pag.* 415: ‘ When ‘ you paſs (ſays he) out of a warm room into a cold, you will ſenſibly feel your ‘ breath to wax ſtark, and even ſtifling with the cold, as you draw it in and out.’ So powerfully and nimbly does the intenſely refrigerated air work upon the organs of reſpiration.

[AND whereas a very credible perſon, now chief phyſician to the *Ruſſian* emperor, being aſked by me concerning the truth of what is reported ſometimes to happen at *Moſcow*, and is reputed the eminenteſt proof, that is readily obſervable of the extreme coldneſs of the air, aſſured me, that he himſelf ſaw the water thrown up into the air fall down actually congealed into ice; Dr. *Fletcher* confirms this report.] For our ambaſſador alſo ſays, *Purchas, pag.* 414. ‘ That the ſharpneſs of the air you may ‘ judge of by this, for that water dropped down, or caſt up into the air, con- ‘ gealed into ice, before it come to ground.’ And I remember, that inquiring about the probability of ſuch relations, he anſwered me, that being at the famous ſiege of *Smolenſko* in *Ruſſia*, he obſerved it to be ſo extremely cold in the fields, that his ſpittle would freeze in falling betwixt his mouth and the ground; and that if he ſpit againſt a tree, or a piece of wood, it would not ſtick, but fall to the foot of it.

17. AMONG the phænomena of cold, relating to the air, I endeavoured to obſerve, whether, upon the change of the weather from warm or mild to cold and froſty, there would appear any difference of the weight of the atmoſphere by its being plentifully furniſhed with a new ſtock of ſuch frigorifick corpuſcles, as ſeveral of the modern philoſophers aſcribe its coldneſs to: but though I ſeveral times obſerved by comparing a good barometer (and ſometimes alſo unſealed weather-glaſſes, furniſhed one with a tincted liquor, and the other with quickſilver) with a good ſealed weather-glaſs, furniſhed with pure ſpirit of wine, that, upon the coming in of clear and froſty weather, the atmoſphere would very early appear ſenſibly heavier than before, and continue ſo, as long as the cold and clear weather laſted; yet by reaſon of ſome conſiderations and trials, that bred ſome ſcruples in me, I refer the matter to more frequent and laſting obſervations, than I yet have been able to make; in which it will concern thoſe, that have a mind to proſecute ſuch trials, not only to conſider, whether or no the increaſed gravity of the atmoſphere may not proceed from ſome other cauſe, than the coming of frigorifick atoms into the air; but to have a ſpecial care, that their baroſcopes be more carefully freed from the air, that is wont to lurk in quickſilver it ſelf, as well as other liquors, than thoſe, in the making of the Torricellian experiment, tubes uſually are, leſt that air getting up into the deſerted part of the tube, do, by its expanſion and contraction, obtain an unſuſpected intereſt in the riſing and falling of the ſubjacent mercurial cylinder, and ſo impoſe upon them.

18. ANOTHER effect, that the cold, eſpecially in northern countries, has oftentimes upon the atmoſphere, is, the making the air more or leſs clear than uſually it is. For in the northern voyages, the ſeamen frequently complain of thick and laſting fogs, whoſe cauſes I ſhall not now conſider, but ſome help to gueſs at them may be given by what we are about to add; namely, that it frequently happens, on the contrary, that when the cold is very intenſe, the air grows much clearer than at other times, probably becauſe the cold by condenſing precipitates the vapours, that thicken the air, and by freezing the ſurface of the earth, keeps in the ſteams, that would elſe ariſe to thicken the air. Not to diſpute, whether it may not alſo ſomewhat repreſs the vapours, that would be afforded by the water it ſelf, ſince ſome of our navigators obſerve, that even when it was not cold enough to freeze the ſurface of the ſea, it would ſo far chill and infrigidate it, that the ſnow would lie on it without melting.

19. I REMEMBER a *Swediſh* extraordinary ambaſſador, and a very knowing perſon, whom I had the honour to be particularly acquainted with, would ſay, when he ſaw a froſty day accompanied with great clearneſs, that it then looked like a *Swediſh* winter; where, when once the froſty weather is ſettled, the ſky is wont for a very long time to be very ſerene and pleaſant; and here in *England* we uſually obſerve the ſharpeſt froſty nights to be the cleareſt. But to confirm our obſervation by a very remarkable inſtance, I ſhall borrow it from a navigator very curious of celeſtial obſervations; which circumſtance I mention to bring the greater credit to the following obſervation of Captain *James*, which in his journal, *pag*. 62. is thus delivered: 'The thirtieth and one and thirtieth of *January*, there appeared in the beginning of the night more ſtars in the firmament, than ever I had before ſeen by two thirds. I could ſee the cloud in *Cancer* full of ſmall ſtars.'

20. To determine what effect the coldneſs of the air may have upon the refractions of the luminaries and other ſtars, I look upon as a work of no ſmall difficulty, and that would require much conſideration as well as time: wherefore I ſhall only add two or three narratives, ſupplied me by navigators, without adding at preſent any thing to the matters of fact.

21. THE firſt is that famous obſervation of the *Dutch* in *Nova Zembla*, who take great pains to evince, by ſeveral circumſtances, ſome of them highly probable, that they were not miſtaken in their account of time; according to which, they concluded, that they ſaw the ſun, whom they had loſt ſight of eleven weeks before, about fourteen days ſooner than he ought to have appeared to them: which difference has been, for aught I know to the contrary, by all that have taken notice of it, aſcribed to the ſtrangely great refraction in that gelid and northern air.

22. AND as for that other extremely cold country, where Captain *James* wintered, it appears by his journal, that he there made divers celeſtial, and other obſervations, which gave him opportunity to take notice of the refraction; and he ſeems to complain, that he found it very great, though among the particulars he takes notes of, there are ſome, that ſeem not very ſtrange, nor are there any, that are near ſo wonderful, as that newly mentioned of the Hollanders in *Nova Zembla*; however in regard of the extreme coldneſs of the winter air in *Charleton Iſland*, it may be worth while to take notice of the following paſſages out of his journal, ſince they may at leaſt help us to conjecture, what is not to be expected in reference to refractions from the coldneſs of the air as ſuch, *page* 61. 'The 21ſt of *January* (ſays he) I obſerved the latitude with what exactneſs I could (it being very clear ſun-ſhiny weather) which I found to be 52 deg. 52 min. This difference is by reaſon, that here is a

'great refraction.' Which laſt clauſe is very obſcure, unleſs it refers, as one may gueſs it does, to what he had elſewhere ſaid, that on his firſt coming to the iſland, *pag*. 46. 'he took the latitude with two quadrants, and found it to be juſt 52 'degrees,' without any minutes. Elſewhere, *pag*. 64. 'my obſervations (ſays he) 'by theſe glaſſes I compared to the ſtars coming to the meridian.' By this means we found the ſun to riſe twenty minutes before it ſhould, and in the evening to remain above the horizon twenty minutes (or thereabouts) longer than it ſhould. And this by reaſon of the refraction.

AND in another place, *March* the 15th. 'This evening (ſays he) *pag*. 66. the 'moon roſe in a very long oval alongſt the horizon.'

I SHALL add one paſſage more out of our author, concerning refractions, not only becauſe it may bear teſtimony to ſome relations of the like kind, that I have mentioned in another treatiſe; but becauſe it is concluded with an obſervation, that (if there be nothing of miſtake in it) is odd enough. 'I had often (ſays he) *pag*. 69. 'obſerved the difference betwixt clear weather and miſty refractious weather in this 'manner. From a little hill, which was near adjoining to our houſe, in the cleareſt 'weather, when the ſun ſhone, with all the purity of air that I could conceive, we 'could not ſee a little iſland, which bare off us ſouth ſouth-eaſt ſome four leagues 'off; but if the weather were miſty (as aforeſaid) then we could often ſee it from 'the loweſt place.'

23. HITHERTO I have treated of the temperature of air in general; and though the paſt diſcourſe have been prolix enough, yet poſſibly I may have no fewer things to ſay, if I would at preſent fall upon the conſideration of the three regions, into which the air is wont to be diſtinguiſhed. For I confeſs I am not altogether without ſcruples, both as to the number, and as to the limits, and as to the qualities aſſigned to theſe aërial regions. But (as I have partly declared in another * tract) though I had time to enter upon ſo intricate a diſquiſition, yet till I have an opportunity to conſult ſome other papers, I know not, whether what I have noted, touching theſe difficulties, may not more properly belong to another treatiſe, than this of cold.

* A ſceptical diſquiſition of Antiperiſtaſis.

24. HAVING thus diſpatched the few experiments I can meet with among my papers, concerning the coldneſs of the air, I now proceed to ſubjoin ſome obſervations, that have occurred to me in the writings or verbal relations of navigators and travellers about that ſubject. But in regard, that the greateſt part of the phænomena of cold, which nature of her own accord preſents us with, ſeem to be produced, either mediately or immediately by the air, we intend not here to treat of the coldneſs of the air in the largeſt ſenſe, but only to take notice of ſome of the choicer inſtances, that ſeem to belong to our preſent argument. And theſe we ſhall annex, either as promiſcuous obſervations at the cloſe of this ſection, or as illuſtrations or proofs of the three following obſervations.

2. THE firſt I ſhall propoſe in theſe terms; 'That the greater or leſſer coldneſs of 'the air, in ſeveral climates and countries, is nothing near ſo regularly proportionate 'to their reſpective diſtances from the pole, or their vicinity to the equator, as men 'are wont to preſume.'

THIS puts me in mind of what I have formerly, either heard from a ſkilful man, or obſerved my ſelf about the difference betwixt places of the ſame latitude in the northern and ſouthern hemiſphere; namely, that of places equally diſtant, the one from the northern, the other from the ſouthern pole, the latter are generally much colder than the former. And, as I remember, I long ſince noted ſome things to this purpoſe; but being not at preſent able to recover them, I ſhall propoſe this only, as that, which may deſerve an inquiry, being not yet ſatisfied, but that in the examples I had taken notice of, ſome accidental and concurrent cauſes may have occaſioned the greater coldneſs obſerved in the places ſeated on the other ſide of the line; as, on this ſide of it, the like cauſes may much vary the coldneſs of differing places of equal latitudes, as we are now going to ſhew by the following teſtimonies.

1. How exceſſive a cold reigns at *Moſcow* and thereabouts in the winter time, when many men loſe their noſes or their toes, and ſome their lives by the extremity of the cold, we have ſeveral times occaſion to take notice of in this treatiſe. And yet at *Edinburgh*, which I find ſome of our modern navigators to place more northerly by above a degree; there, I ſay, and in the neighbouring places, the air is known to be temperate enough, and the cold very tolerable: and it is affirmed, that the ſnow very rarely lies any long time on the ground after it is fallen.

2. IN the voyage made for diſcoveries northward by Mr. *Pool*, in the year 1610, I find this paſſage, *pag*. 702. ‘ I was certified, that all the ponds and lakes were ‘ unfrozen, they being freſh water; which putteth me in hope of a mild ſummer ‘ here, after ſo ſharp a beginning, as I have had; and my opinion is ſuch (and I ‘ aſſure my ſelf it is ſo) that a paſſage may be as ſoon attained this way by the pole, ‘ as any unknown way whatſoever, by reaſon the ſun doth give a great heat in this ‘ climate; and the ice (near the 79th degree) I mean that, that freezeth here, is ‘ nothing ſo huge as I have ſeen in 73 degrees.’

To this agrees the teſtimony of the Hollanders in their firſt voyage to *Nova Zembla*, in which the writer of it, *Gerat de Veer*, ſpeaks thus, *pag*. 473, 474. ‘ We have ‘ aſſuredly found, that the only and moſt hinderance to our voyage was the ice, that ‘ we found about *Nova Zembla*, under 73, 74, 75 and 76 degrees, and not ſo much ‘ upon the ſea, between both the lands; whereby it appeareth, that not the nearneſs ‘ of the north pole, but the ice, that cometh in and out from the Tartarian ſea ‘ about *Nova Zembla*, cauſed us to feel the greateſt cold. Therefore in regard, that ‘ the nearneſs of the pole was not the cauſe of the great cold that we felt, *&c.* And a little after,——‘ It is true (ſays he) that in the country lying under 80 degrees ‘ (which we eſteem to be *Greenland*) there is both leaves and graſs, to be ſeen, ‘ wherein ſuch beaſts, as feed of leaves and graſs, as harts, hinds, and ſuch like ‘ beaſts, live; whereas to the contrary in *Nova Zembla* there groweth neither leaves ‘ nor graſs, and there are no beaſts there, but ſuch as eat fleſh, as bears and foxes, ‘ *&c.* although *Nova Zembla* lieth 4, 5, and 6 degrees more ſoutherly from the pole, ‘ than the other land aforeſaid.’

AND to this purpoſe I remember what is related by the learned *Joſephus Acoſta*, concerning the heats and colds in the torrid zone, and elſewhere: *Acoſta*, *lib*. 2. *cap*. 9. *pag*. 101. ‘ When I paſſed (ſays he) to the *Indies*, I will tell what chanced unto ‘ me: having read what poets and philoſophers write of the burning zone, I perſuaded my ſelf, that coming to the equinoctial, I ſhould not endure the violent ‘ heat: but it fell out otherwiſe, for when I paſſed, which was when the ſun was ‘ there for zenith, being entered into *Aries*, in the month of *March* I felt ſo great a ‘ cold, as I was forced to go into the ſun to warm me. What could I elſe do then ‘ but laugh at *Ariſtotle*'s meteors and his philoſophy, ſeeing that in that place, and at ‘ that ſeaſon, when as all ſhould be ſcorched with heat according to his rules, I and all ‘ my companions were a-cold? In truth there is no region in the world more pleaſant ‘ and temperate than under the equinoctial, although it be not in all parts of an equal ‘ temperature, but have great diverſities. The burning zone in ſome parts is very

‘ temperate, as in *Quito*, and on the plains of *Peru*; in ſome parts very cold, as at ‘ *Potoſi*; and in ſome very hot, as in *Ethiopia*, *Braſil* and the *Moluccoes*.’ And within two chapters after, he diſcourſes more largely of ſome of theſe particulars. And again chapter the 12th, ‘ You may continually (ſays he) *pag*. 109. ſee upon the ‘ tops of theſe mountains ſnow, hail, and frozen waters; and the cold ſo bitter, as ‘ the graſs is all withered, ſo as the men and beaſts, which paſs that way, are ‘ benumbed with cold. This, as I have ſaid, is in the burning zone, and it happens ‘ moſt commonly, when they have the ſun for zenith.’

These teſtimonies of a learned man, that writes upon his own knowledge, I thought worth producing, to make it probable, that as in ſeveral countries the heat does not always anſwer to the nearneſs of places to the line; ſo in northern regions the cold may not always be proportionate to their vicinity to the pole. In Mr. *Hudſon*'s ſecond voyage, written by himſelf, he mentions, that above 71 degrees, though they were much peſtered with ice, about the end of *June*, ‘ that day (when ‘ this happened, *Purchas*, *pag*. 578. was calm, clear, and hot weather; adding of ‘ the next day alſo, that it was calm, hot, and fair weather.’ And *Acoſta* tells us, ‘ that we ſee theſe differences, not only on the land, but alſo on the ſea: there are ‘ ſome ſeas, where they feel great heat, as the report of that of *Mazambigus*, and ‘ *Ormus* in the Eaſt, and of the ſea of *Panama* in the Weſt. There are other ſeas in ‘ the ſame degree of height very cold, as that of *Peru*, in the which we were a-cold, ‘ when we firſt ſailed it, which was in *March*, when the ſun was directly over us. ‘ In truth, on this continent, where the ſand and ſea are of one ſort, we cannot ‘ imagine any other cauſe of this ſo great a difference, but the quality of the wind, ‘ that doth refreſh them.’

But to multiply no more inſtances, we ſhall conclude with this one, that *Charleton Iſland*, where Captain *James* wintered (and of which we ſo often have occaſion to make mention in our hiſtory) though it ſeems by the effects to be a colder region, than even the country about *Moſcow*, and perhaps as cold as *Nova Zembla* it ſelf; yet Captain *James*, who had ſeveral times occaſion to take the latitude of it, (ſee *James*'s voyage, *pag*. 61, and 81, and elſewhere) aſſigns it the ſame elevation, and conſequently the ſame diſtance from the pole, with *Cambridge*, whoſe latitude he reckons to be 51 degrees beſides minutes, and whoſe air is very well known to be very temperate. And it is remarkable, that though this place, whoſe latitude is ſhort of 52 degrees, was found uninhabitable by reaſon of the cold, (*Purchas*, *pag*. 569.) yet not only in Mr. *Hudſon*'s voyage, the writers admoniſh the readers to take notice, ‘ That although they ran along near the ſhore, they found no great cold, which ‘ made them think, that if they had been on ſhore, the place is temperate.’ *Joſephus Acoſta*, *lib*. 2. *pag*. 111, 112. And yet in this place they reckon themſelves to have reached the 78th degree of latitude: and our recenter navigations inform us, that ſeveral parts of *Greenland*, to which this newly-mentioned coaſt belonged, are well enough inhabited: and one of our Engliſh navigators aſſures us, that the true height of *Puſtozera* in *Ruſſia* is no leſs than 68 degrees and a half, if not more, and yet that is a town not only well inhabited, but of great trade. But in *Hudſon*'s voyage I find what is more ſtrange, that under the 81ſt degree of latitude, beyond which they diſcovered land very far off, but (beyond which none is thought to have actually ſailed towards the pole) ‘ they found it during the whole day clear weather, with little ‘ wind, and reaſonably warm.’ *Purchas*, *pag*. 571. And beyond 80 degrees, they not only found a ſtream or two of freſh water, ‘ but found it hot on the ſhore, and ‘ drank water to cool their thirſt, which they alſo commended.’

II. THE next obſervable I am to propoſe about the coldneſs of the air, is this, ‘ That the degrees both of heat and cold in the air may be much greater in the ſame ‘ climate, and the ſame place, at ſeveral ſeaſons of the year, or even at ſeveral times ‘ of the ſame day, than moſt men would believe.’

FOR the proof of this propoſition, we ſhall ſubjoin two ſorts of teſtimonies, of travellers, and navigators; the former ſhewing, that in countries, where it is very cold in winter, it may nevertheleſs be hot in ſummer; and the latter manifeſting, that even on the ſame day, as well as in the ſame place, the heat and cold, that ſucceeded one another, may be one of them ſenſible, though the other were extreme, or may perhaps be both of them conſiderable.

To make this good, we ſhall produce the following teſtimonies.

1. Dr. *Giles Fletcher*, Engliſh ambaſſador to the *Muſcovian* emperor, in his treatiſe of *Ruſſia*, and the adjoining regions, has this memorable paſſage to our preſent purpoſe: ‘ The whole country (ſays he, *pag*. 414.) differeth very much from itſelf, ‘ by reaſon of the year; ſo that a man would marvel to ſee the great alteration and ‘ difference betwixt the winters and ſummers in *Ruſſia*. The whole country in the ‘ winter lieth under ſnow, which falleth continually, and is ſometime of a yard or ‘ two thick, but greater towards the north; the rivers and other waters are all frozen ‘ up, a yard or more thick, how ſwift or broad ſoever they be; and this continueth ‘ commonly for five months, to wit, from the beginning of *November*, till towards ‘ the end of *March*; what time the ſnow beginneth to melt, ſo that it would breed a ‘ froſt in a man to look abroad at that time, and ſee the winter's face of that country.’ And a little after he adds, *Purchas*, 415. ‘ And yet in the ſummer time you ſhall ‘ ſee ſuch a new hue and face of a country, the woods (which for the moſt part are ‘ all of fir and birch) ſo freſh, and ſo ſweet; the paſtures and meadows ſo green, ‘ and well grown (and that upon the ſudden) ſuch variety of flowers, ſuch noiſe of ‘ birds (eſpecially of nightingales, that ſeem to be more loud, and of a more variable ‘ note, than in other countries) that a man ſhall not lightly travel in a more pleaſant ‘ country.’ And ſome lines after, ‘ As the winter exceedeth in cold, ſo the ſummer ‘ inclineth to over-much heat, eſpecially in the months of *June*, *July*, and *Auguſt*, ‘ being much warmer than the ſummer air in *England*.’

Voyage de Moſcovie & de Perſe, livre 3. p. m. 117, 118, 119.

ALMOST like things have been much more recently affirmed by the learned *Olearius*, ſecretary to the Duke of *Holſtein*'s embaſſy into *Ruſſia*, and now *Bibliothecarius* to the preſent Prince of *Holſtein*. And an acquaintance of mine, who, after having lived in *Italy*, paſſed a ſummer in *Ruſſia*, aſſured me, that he ſcarce in *Italy*, did ever eat better melons, than ſome, which he had eaten at *Moſcow*, of a ſtrange bigneſs; which bears witneſs to that almoſt incredible relation of *Olearius*, who (after having much praiſed their goodneſs at *Moſcow*) affirms, that he there met with melons of 40 pound weight, of which he there teaches the culture. (*pag*. 119.)

AT the royal city of *China*, *Pequin*, which ſcarce exceeding the 42d degree of latitude, one would expect, that as the ſummer is very warm, ſo the winter ſhould be very mild, as it is obſerved to be in divers places of *Spain*, *Italy* and *Greece*, that have the ſame, or a more northern latitude: and yet the learned Jeſuit *Martinius*, who lived many years in *China*, aſſures us, that uſually for four whole months together all the rivers are ſo hard frozen, that not only all ſhips are cloſed, and kept immoveable by the ice, but that alſo horſes, waggons, and even the heavieſt carriages do ſecurely paſs over the ice. Concerning which he adds this ſtrange circumſtance, that it is uſually made in one day, though to its diſſolution it require many.

*Proſper Alpinus*, in his learned treatiſe *de medicina Ægyptiorum*, *lib.* 1. *cap.* 6. tells us, that at *Grand Cairo*, where he practiſed phyſick, though that famous metropolis of *Ægypt* be diſtant ſix degrees from the tropick of *Cancer*, yet the air, which in ſummer is almoſt inſupportably hot, in winter is ſometimes very conſiderably cold; adding, that there is not any ſort of diſeaſes, that proceed (as he is pleaſed to ſpeak) from diſtillations from the head, to which the people are not there ſubject. To theſe inſtances we ſhall annex but two more, but thoſe remarkable ones.

The firſt is mentioned by *Purchas*, as communicated to him by an eye-witneſs, in theſe words: 'This I thought good at our parting to advertiſe thee, that Mr. *Hebey* hath affirmed to me, touching the diverſity of weather in *Greenland*, that one day it hath been ſo cold (the wind blowing out of ſome quarter) that they could ſcarce handle the frozen ſails; another day ſo hot, that the pitch melted off the ſhip, ſo that hardly they could keep their cloths from pollution: yea, he hath ſeen at midnight tobacco lighted or fired by the ſun-beams with a glaſs.' The other example, I am to produce, is no leſs remarkable; namely, that in the often mentioned *Charleton Iſland*, where that winter was as ſharp, perhaps, as any known place of the habitable world, Captain *James* his journal gives us this account of the weather: 'In *June* the ſixteenth (ſays he, *pag.* 81.) was wondrous hot, with ſome thunder and lightning, ſo that our men did go into the ponds aſhore to ſwim, and cool themſelves; yet was the water very cold ſtill. Here had lately appeared divers ſorts of flies, as butterflies, butchers-flies, horſe-flies, and ſuch an infinite abundance of blood-thirſty muſkitoes, that we were more tormented with them, than ever we were with the cold weather. Theſe (I think) lie dead in the old rotten wood all the winter, and in ſummer they revive again. Here be likewiſe infinite companies of ants, and frogs in the ponds upon the land.'

Thus we ſee, what difference there may be in the ſame place betwixt the temperature of the air in the winter and ſummer. We ſhall now add, what may appear more ſtrange, that there may be very great diſparities in the heat and coldneſs of the air, not only in the ſame place, but within the compaſs of the ſame day.

The lately mentioned *Alpinus* affords me an example to this purpoſe in *Ægypt* it ſelf, where one would expect a much more uniform heat. *Hyeme* (ſays he, pag. 9.) *nocturnus aer admodum frigidus obſervatur, qui oborto ſole paulo poſt parum incaleſcit, in meridieque plurimum; adveniente vere nocte rurſum in frigidum permutatur, ita, at aër ille valdè inæqualis ſit dicendus, ab ipſiuſque illa inæqualitate plurimi morbi originem ducunt atque generatur, qui eo tempore per urbem vagantur.*

The learned *Olearius* relating how he travelled with the ambaſſadors, whoſe ſecretary he was, over a branch of mount *Taurus*, takes notice, that it being after the middle of *June*, the air of that hot region of *Perſia* obliged them only to travel by night, and yet the nocturnal cold was ſo great, that they were all benumbed with it, inſomuch, that they were hardly able to alight from their horſes; adding, that the ſudden change from an extreme cold to the exceſſive heat, they were again expoſed to the next day, caſt no leſs than 15 of their company into ſtrong burning fevers at once. (Which brought into my mind the complaint of good *Jacob*, who, though he lived in an eaſtern country, when he had ſaid, *that in the day the drought conſumed him*, adds, *and the froſt by night.*)

And the ſame curious traveller mentions, that in another country in *Perſia*, called *Faclu*, notwithſtanding the heat of the region (at the end of *March*, at which time they paſſed that way) they ſaw and felt in one night, which they were forced to paſs without their tents, both lightning, and thunders, and winds, and rain, and ſnow, and ice.

We will conclude with a remarkable inſtance, afforded us by the journal of the Engliſh, that wintered at *Charleton Iſland*. 'The ſeaſon here in this climate (ſays the 'often quoted author of the voyage) is moſt unnatural; for in the day-time 'it will be extreme hot, yea, not endurable in the ſun; which is, by reaſon, 'that it is a ſandy country. In the night again, it will freeze an inch thick in 'the ponds, and in the tubs about, and in our houſe, and all this towards the latter 'end of *June*.'

III. The third obſervable I intended to take notice of about the coldneſs of the air, may be comprized in this propoſition, 'That in many places the tempera'ture of the air, as to cold and heat, ſeems not to depend ſo much upon the 'elevation of the pole, as upon the nature and circumſtances of the winds, that 'blow there.'

It would require a very long diſcourſe to treat in this place of winds in general, and much more to examine the ſeveral cauſes of winds, that are aſſigned by ſeveral authors; and therefore when I have once given this intimation, that divers of theſe opinions may be more eaſily reconciled, than the maintainers of them ſeem to have thought, to the truth, if not to one another; the cauſes, that may produce wind, being ſo various, that many of thoſe propoſed may each of them in ſome caſes be true, though none of them in all caſes be ſufficient: having hinted this, I ſay, it may ſuffice, on this occaſion, to ſubjoin three or four obſervations, to prove and illuſtrate the matter of fact delivered in the propoſition.

And firſt, it is a known obſervation in theſe parts of the world, that northerly and north-eaſterly winds do at all times of the year bring cold along with them, and commonly, if it be winter, froſt. And here in *England* I have ſometimes wondered at the power of the winds, to bring not only ſudden froſts, but ſudden thaws, when the froſt was expected to be ſettled and durable; which yet ſeems to hold commonly, but not without exception. For during one of the conſiderableſt fits of froſt and ſnow, that I have taken notice of in *England*, I remember, that I obſerved (not without ſome wonder) that the wind was many days * ſoutherly; unleſs it may be ſaid, that this ſoutherly wind was but the return of a ſtream of northerly wind, which had blown for many days before, and might by ſome obſtacles, and agents, not here to be inquired after, be made to wheel about, or recoil hither, before it had loſt the greateſt portion of the refrigerating corpuſcles it conſiſted of before.

The formerly mentioned *Proſper Alpinus* attributes ſtrange things to the northerly wind, that blows in *Egypt*, as to the cooling and refreſhing the air, in ſpite of the violent heats, that would otherwiſe be intolerable. And many in † *Egypt* aſcribe to the *Æteſian* winds that almoſt miraculous ceaſing of the plague at *Grand Cairo*, of which we elſewhere ſpeak. (*Ibid. lib.* 1. *cap.* 6.) *Dominatur autem aër* (ſays he) *ſummè calidus, ipſius cœli, ut dictum eſt, ratione, quod hæc civitas à Tropico Cancri tantum* 6. *gradibus diſtet. Quâ brevi intercapedine dum ſol ad illum accedit Tropicum, & illorum Zenith ſit propinquior, aër ille valdè incaleſcit, & niſi Æteſiæ venti*

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* The weather was ſnowy and foggy, freezing our rigging, and making every thing ſo ſlippery, that a man can ſcarce ſtand. And all this with the wind ſoutherly, ſays Captain *James*, (*pag.* 104.) in his journal, the 26th of *Auguſt*.

† *Ab his ventis aërem alteratum, eſſe cauſam, cur peſtis illa diſſolvatur, multi illorum affirmant. Quod etiam non videtur penitus à veritate alienum, quando id multis etiam rationibus nobis perſuaderi poſſit, imprimiſque*, &c. Proſp. Alpin. lib. 1. De medicina Ægypt. cap. 18.

*tunc à ſeptentrione ſpirarent, vehementiſſimus, & qui vix à noſtris perferri poſſit, caloris æſtus ſentiretur.*

*Advenæ noſtri iis provenientibus ad ſubterranea loca confugiunt, in quibus morantur, quouſque ille ventorum ardor reſiderit atque ceſſaverit. Conjunxit hæc incommoda Deus optimus cum aliis quibuſdam bonis, nam ubi calidiſſimi illi venti conticuere, ſtatim à ſeptentrione flare alii incipiunt, qui ſubitaneum inflammatis atque laxatis corporibus ſolatium præſtant. Si enim illi diu perſeveraverint, nemo in eâ regione vivere poſſit.* Ibid. lib. 1. cap. 7. pag. 11.

Whence winds ſhould have this power to change the conſtitution of the air, and eſpecially to bring cold along with them, is not ſo eaſy to be determined. Indeed the other qualities, and even the heat, that is obſervable in winds, may for the moſt part be probably enough derived from the qualities of the places, by which they paſs. Of this we have already given an example or two in the paſſages lately mentioned. And it may be further confirmed by what *Acoſta* ſays, that he himſelf ſaw in ſome part of the *Indies*, (namely, *Joſephus Acoſta, lib.* 3. *cap.* 9.) ‘ That the iron gates were ſo ‘ ruſted and conſumed by a peculiar wind, that preſſing the metal between your ‘ fingers, it would be diſſolved and crumbled, as if it had been hay or parched ſtraw.’ And this learned traveller, who ſeems to have taken peculiar notice of the winds, affords us, in divers places of his book, ſeveral examples to confirm what we were ſaying, (though he take not the nature of the regions, along which the wind blows, to be alone in all caſes a ſufficient cauſe of their qualities) of which yet we ſhall now mention but theſe two memorable paſſages. *Lib.* 3. *cap.* 2. *pag.* 120. ‘ In a ſmall ‘ diſtance (ſays he) you ſhall ſee in one wind many diverſities. For example, the ‘ *Solanus* or Eaſtern wind is commonly hot and troubleſome in *Spain*; and in *Murcia*, ‘ it is the coldeſt and healthfulleſt that is, for that it paſſeth by the orchards, and ‘ that large champion, which we ſee very freſh In *Carthagena*, which is not far ‘ from thence, the ſame wind is troubleſome and unwholſome. The Meridional, ‘ (which they of the ocean call South, and thoſe of the Mediterranean ſea, *Mezzo* ‘ *Giorno)* commonly is rainy, and boiſterous, and in the ſame city, whereof I ‘ ſpeak, it is wholeſome and pleaſant.’ And in his deſcription of *Peru*, *lib.* 3. *cap.* 3. ſpeaking of the South and South-weſt, he affirms, that this wind yet in this region is marvellous pleaſing.

But though, as we were ſaying, many other qualities of winds may be deduced from the nature and condition of the places, by which they paſs; and though the heat alſo, which *Proſper Alpinus* (as we lately took notice) attributes to the ſoutherly winds, that blow in *Egypt*, may be probably aſcribed to the heated exhalations and vapours they bring from the ſouthern and parched regions they blow over; yet whence the great coldneſs of northerly and eaſterly winds ſhould come, may be ſcrupled at by many of the modern philoſophers, who, with divers Carteſians, will not admit, that there are any corpuſcles of cold.

And poſſibly I could, about theſe matters, propoſe ſome other difficulties, not ſo eaſy to be reſolved. But not being now to diſcuſs the hypotheſis about cold, I think it will be more proper in this place, inſtead of entering upon diſputes and ſpeculations, to ſubjoin an experiment, that I made, to give ſome light about this matter.

Considering then, that I had not met with any trial of the nature of that I am about to mention, and that ſuch a trial might poſſibly prove lucriferous, I cauſed a pretty large pair of ordinary bellows to be kept a good while in the room, where the experiment was to be made, that it might receive the temperature of the air in that chamber: then placing upon a board one of thoſe flat-bottomed weather-glaſſes, that I elſewhere

I elſewhere deſcribed to contain a moveable drop of pendulous water, blowing at ſeveral times with intermiſſions upon the bubble or lower end of the weather-glaſs, though the wind blown againſt my hand were, as to ſenſe, very manifeſtly cold, yet it did not cool the air included in the bubble, but rather a little warmed it, as appeared by a ſmall, but ſenſible, aſcenſion of the pendulous drop each time, that, after ſome interpoſed reſt, the lower part of the glaſs was blown upon, which ſeemed to proceed from ſome ſmall alteration towards warmth, that the air received by its ſtay (though ſhort) in the bellows, as ſeemed deducible from hence, that if by cloſely covering the clack, the matter were ſo ordered, that the air, that ſhould come into the bellows, muſt come in all at the noſe: if this noſe being held very near the bubble of the weather-glaſs, the air were, by opening the bellows, ſuddenly drawn in, that ſtream or air of wind coming from a part of the window where the air was a little cooler than that, which was wont to come out of the bellows, would not, as the other, make the pendulous drop riſe, but rather the contrary.

THIS done, we proceeded to ſhew by experiment, that though a wind were nothing but a ſtream of air, yet in its paſſage it might acquire a conſiderable coldneſs diſtinct from that, which it has by virtue of its motion; though upon the ſcore of that, we ſee, that air moved by a fan, or (as in our newly-mentioned trial) by a pair of bellows, might, to our touch, feel cold; nor did we forbear to expect a good event of our trial, upon the doubt, that may be raiſed, whether there be frigorifick corpuſcles or no. For whatever become of that queſtion, I thought I might expect, that whether or no ice emit corpuſcles, that are univerſally frigorifick, yet the air, being, either by them, or upon what account ſoever, highly refrigerated, the corpuſcles, that compoſe this cold air, being moſt of them driven on before it by the wind, that meets them in its way, will, in a ſenſe, prove frigorifick, in regard of a leſs cold body, which they ſhall happen to be blown upon; and accordingly, having provided a ridge-tile inverted, and half filled the cavity, which looked upwards, with a mixture of ice and ſalt; and having likewiſe put the iron pipe of the bellows upon that mixture, and then covered it with more of the ſame, that ſo the pipe being ſurrounded, as far as conveniently it could be, with ice and ſalt, the air contained in it might thereby be highly refrigerated; I found, that blowing wind out of the bellows upon my hand, that wind felt much more cold than that, which had been before blown upon my hand out of the ſame bellows, before the frigefactive mixture was applied to it. But for fear my ſenſe of feeling ſhould deceive me, I cauſed a weather-glaſs, made after the common manner, but with a more ſlender pipe, to be ſo placed, that the noſe of the bellows (which, together with the tile and ice, was upheld with a frame) lay in a level with the bubble of the thermometer; and then blowing the refrigerated air of the bellows upon the globular part of the glaſs, I ſaw the water in the cylindrical part and ſhank manifeſtly aſcend, as it was wont to do upon the refrigeration of the included air: and as this aſcenſion of the liquor continued, during three or four blaſts of the bellows, ſo, upon the ceſſation of the artificial wind, the water ſubſided by degrees again, till by freſh blaſts it was made to aſcend. Laſtly, having repeated this experiment, we thought fit to try, how much the air, refrigerated immediately by the frigorifick mixture, would produce a colder wind than the former; and accordingly drawing back the noſe of the bellows, that the air, that ſhould be blown out, might paſs along the cavity left in the frigorifick mixture by the iron pipe (of the bellows) which we had withdrawn, the wind was manifeſtly more cold than before, and had a greater operation on the weather-glaſs, it was blown upon.

This experiment, if carried on, and proſecuted, may poſſibly prove luciferous; but I will not take upon me here to determine, whether all cold winds muſt neceſſarily be made ſo by frigorifick corpuſcles properly ſo called: ſince I have ſometimes ſuſpected, that ſome winds may be cold, only by conſiſting of, or driving before them thoſe higher parts of the air, that, by reaſon of the languid reflection of the ſun-beams, in that upper (or perhaps arctick) region of the air, are for the moſt part very cold. For it may be obſerved, that rains oftentimes very much and ſuddenly refrigerate the lower air, when no wind, but what the clouds and rain make, accompanies them, as if they brought down ſtore of cold air with them from that upper region; which *Acoſta*, and one I converſed with, that viſited far higher mountains than the *Alps*, affirm to be in ſome places (for I am not ſatisfied, that it is ſo every where) exceeding cold, both in hot climates, and in hot ſeaſons of the year. And I obſerve that the Hollanders do, in more places than one or two, mention the northerly and north-eaſterly winds, to be thoſe, that brought them the prodigious colds they met with, though in *Nova Zembla*, where they were expoſed to them, be ſo northwards, that it lies within 16 or 17 degrees of the pole itſelf. This being a bare ſuſpicion, it may ſuffice to have touched it. But I ſhall ſubjoin two or three inſtances on the occaſion of our propoſition, concerning the influence of the winds upon the air, and to ſhew more particularly, that even cold winds receive not always their qualities ſo much from the quarter, whence they blow, as from the regions, over which they blow: I ſhall therefore begin with what is delivered by Mr. *Wood*, in his *New England*'s Proſpect, *part* I. *chap.* 2. 'Whereas in *England* (ſays he) moſt of the cold winds and weathers come from the ſea, and thoſe ſituations are counted moſt unwholeſome, that are near the ſea-coaſt; in that country it is not ſo, but otherwiſe.' And having added, as his reaſon, that the 'north-eaſt wind, coming from the ſea, produces warm weather, melting the ſnow, and thawing the ground;' he ſubjoins, 'only the North-weſt wind coming over the land, is the cauſe of extreme cold weather, being always accompanied with deep ſnows, and bitter froſts, *&c.*' To which paſſages we ſhall add only one out of Captain *James*, as being conſiderable to our preſent purpoſe. Captain *James*'s voyage, *page* 52, 53. 'The winds (ſays he) ſince we came hither, have been very variable and unconſtant; and till within this fortnight, the ſoutherly wind was coldeſt. The reaſon I conceive to be, for that it did blow from the main land, which was all covered with ſnow, and for that the North winds came out of the great bay, which hitherto was open.'

## TITLE XIX.

### *Of the ſtrange effects of Cold.*

1. TO enumerate and proſecute all the ſeveral effects of cold, being the chief work of the whole book, it is not to be expected, that they ſhould be particularly treated of in this one ſection of it, wherein I ſhall therefore confine myſelf to mention only thoſe effects of cold, that are not familiar, but ſeem to have in them ſomething of wonderful; nor muſt I take notice of all them neither, leſt I ſhould be guilty of uſeleſs repetitions, but only of them, which either are not at all, or are but incidentally or tranſiently delivered in the foregoing ſections. Nor is it to be expected, that I ſhould pawn my credit for the truth of every one of the relations I am about to ſubjoin. For if they had not ſomething of extraordinary, and, conſequently, that may beget ſome diffidence in wary men, they would not be proper for the title of this ſection: and moſt of them, that they may be fit to be placed here, muſt be the effects

of ſuch extreme degrees of cold, that I cannot, in this temperate climate of ours, examine the truth of them by my own trials: ſo that all I can do, is to make choice of ſuch relations, as are almoſt all of them delivered by the relators, as upon their own knowledge. And even this may perchance not only gratify and excite the curioſity of ſome, who are pleaſed with no things ſo much, as with thoſe, that have ſomewhat in them of prodigy; and (which is more conſiderable) their narratives may afford the ingenious ſuch ſtrange phænomena, that the explication of them may ſerve both to exerciſe their wits, and try their hypotheſis.

2. It ſeems not neceſſary, in the marſhalling theſe obſervations, to be ſcrupulous about method; but yet to avoid confuſion, we ſhall firſt mention the effects of cold, as to thoſe four great bodies of that part of the ſublunary world we live in, that are commonly reputed elements; and thence we will proceed to take notice of the effects of cold upon ſome other inanimate bodies, and, for an inſtance of its operation on living creatures, upon men.

Purchas, lib. 3, cap. 5. ſect. 2. pag. 495.

Of the power of cold, either to ſtraiten the ſphere of activity of fire, or to hinder its wonted effects, the chief examples I have met with are recorded, partly by the *Dutch* in *Nova Zembla*, and partly by Captain *James*, when he wintered in *Charleton Iſland*. Theſe Hollanders in one place ſpeak thus; 'The twentieth it was fair and ſtill weather, the wind eaſterly, then we waſhed our ſheets, but it was ſo cold, that when we had waſhed and rung them, they preſently froze ſo ſtiff, that although we laid them by a great fire, the ſide that laid next the fire thawed, but the other ſide was hard frozen, *&c.*' Elſewhere thus: 'We were in great fear, that if the extremity of the cold grew to be more and more, we ſhould all die there with cold: for what fire ſoever we made, it would not warm us.' And becauſe it were tedious to tranſcribe all, that their journals afford us to our preſent purpoſe, we will conclude with this paſſage: 'Hereby we were ſo faſt ſhut up into the houſe, as if we had been priſoners; and it was ſo extreme cold, that the fire almoſt caſt no heat, for as we put our feet to the fire, we burnt our hoſe before we could feel the heat, ſo that we had work enough to do to patch our hoſe; and, which is more, if we had not ſooner ſmelt than felt them, we ſhould have burnt them ere we had known it.' Though Captain *James* wintered in a country many degrees remoter from the pole, than *Nova Zembla*, yet in one place he gives us this account of the cold's power to reſtrain or oppoſe the action of fire: (Captain *James*, *p.* 65.) 'The cook's tubs, wherein he did water his meat, ſtanding about a yard from the fire, and which he did all day ply with melted ſnow water, yet in the night ſeaſon, while he ſlept but one watch, would they be firm frozen to the very bottom. And therefore was he fain to water his meat in a braſs kettle, cloſe adjoining to the fire; and I have many times both ſeen and felt, by putting my hand into it, that ſide, which was next the fire, was very warm, and the other an inch frozen. I leave the reſt to our cook, who will almoſt ſpeak miracles of the cold.'

Thus far our Engliſh navigator, whoſe relation, compared with thoſe of the Hollanders, makes me not ſo much wonder, as I once did, that men ſhould relate to *Marcus Polus*, that there is a certain plain in *Tartary*, ſituated between ſome of the higheſt mountains in the world, 'where, if fire be kindled, it is not ſo bright, nor ſo effectual to boil any thing, as in other places.' (*Purchas*, *lib.* 1. *cap.* 4. *pag.* 74.) For ſo *Purchas* renders that paſſage; whence occaſion has been taken to impute to *Marcus Polus*, a writer not always half ſo fabulous, as many think him, that he affirmed, that there was a country in *Tartary*, where fire could not be kindled.

4. And as for the other newly mentioned relations of ſeamen and travellers, though to us that live in *England*, they cannot but ſeem very ſtrange; yet I am kept from rejecting them as utterly incredible, by conſidering, that ice and ſnow having before their congelation been water, muſt in probability owe their coldneſs to that which reigned in the air: ſo that if in any place nature has, either ſo plentifully ſtocked the air itſelf with frigorifick expirations, or other corpuſcles (if we will admit any ſuch, or have upon any other account rendered it as cold, as it can make ice and ſnow to be, even here amongſt us; I know not, why the northerneſs of the climate, and perhaps ſome ſaline expirations from the earth and ſea, may not there diffuſe through the air a cold ſuperior to that, which by ſmall quantities of ice (or ſnow) and ſalt can at a ſmall diſtance be produced here. And this cold is ſo intenſe, that by pouring ſome water on a joint-ſtool, and placing on it a ſilver tankard, or other convenient veſſel, we may, as experience has aſſured me, with beaten ice (or ſnow) and ſalt, and a little water (which is added to haſten the ſolution of the other) nimbly ſtirred together in the pot, make the mixture freeze the external water quite through the tankard; and they may be by this way ſo hard frozen together, as that by lifting up the pot, you may lift up the joint-ſtool too, and that (which is the circumſtance, for which I mention this) juſt by the fire, which in this caſe is unable to hinder ſo difficult an operation of the cold.

5. Thus much of the effects of cold, in reference to fire. What the ſame quality may perform upon air, we ſhall ſay but little of in this place, becauſe we treat of thoſe phænomena, partly in the foregoing ſection of the coldneſs of the air, and partly in other places. Only we ſhall not here pretermit a teſtimony of the learned *Olearius*, who, as an eye-witneſs, confirms what we elſewhere deliver of the high degree of cold, to which the air may be brought. For he tells us, 'That in '*Moſcovy* he experimentally found that, which others left recorded in their 'writings, that one's ſpittle would be congealed before it reached the ground, 'and that water would freeze as it was dropping down.' (*Olear. lib.* 3. *p. m.* 117.

6. Of the effects of cold upon water, we ſhall not need to ſay much in this place, ſince the two notableſt of them being the power cold has to congeal water ſuddenly, and the force it has to turn vaſt quantities of it into ſolid ice; of the former I have newly given, out of *Olearius*, an example as eminent as almoſt any, that is to be met with; and of the latter alſo I have given ſeveral inſtances, in the ſection, that treats of ice: yet two or three notable inſtances, which we do not elſewhere mention, it will not be improper to deliver in this place.

7. The firſt declares, that notwithſtanding the warmth of the inſide of a man's mouth, his ſpittle may be frozen even there. 'The 27th of *September* (they are the 'words of *Gerat de Veer*) it blew hard north-eaſt, and it froze ſo hard, that as we 'put a nail into our mouths (as when men work carpenter's work, they uſe to do) 'there would ice hang thereon, when we took it out again, and made the blood 'follow.' (*Purchas*, *pag.* 461.) The like relation (if I miſremember not) I have met with in a modern Engliſh navigator; and it is very little, if at all more ſtrange, than what is affirmed by Queen *Elizabeth*'s ambaſſador to the *Ruſſian* emperor: 'In 'the extremity of winter (ſays Doctor *Fletcher*, ſpeaking of *Muſcovia*) if you hold a 'pewter diſh or pot in your hand, or any other metal, except in ſome chamber, 'where their warm ſtoves be, your fingers will ſtick faſt to it, and draw off the 'ſkin at the parting.'

8. The other inſtance, I intend to mention, is this, that though *Macrobius*, and other learned men both ancient and modern, will not allow ſalt water to be congealable;

gealable; yet the *Dutch* at *Nova Zembla* relate even in the midſt of *September* (and as the marginal note ſays, in a night) 'it froze two inches thick in the ſalt water.' (*Purchas, pag.* 491.)

9. As to the effects of violent colds upon the earth, what they would prove upon pure elementary earth (if any ſuch there be) I can but conjecture; but as for that impure or mingled earth, which we commonly tread on, the effects of extreme cold upon that may be very notable. For *Olearius* relates, 'that in the year 1634, the 'cold was ſo bitter at *Moſcow*, that in the great market-place he ſaw the ground 'opened by it ſo, that there was made a cleft of many yards long, and a foot broad.' [And the preſent great duke of *Muſcovy*'s phyſician being aſked by me concerning the truth of ſuch relations, anſwered me, that he himſelf had in thoſe parts ſeen the ground reduced by the cold, to gape ſo wide, that a child's head might well have been put into the cleft.]

10. IT is ſomewhat ſtrange, that the violent heat of ſummer, and the extreme cold of winter ſhould both of them be able to produce in the ground the like effects: but whether to make theſe gaping chinks, that we have been ſpeaking of, the ſurface of the ground expoſed to the air, being firſt frozen, is afterwards broken by the expanſive force of the moiſt earth underneath, to which the cold at length pierces, and congealing it, makes it ſwell, and heave, and ſo burſt or cleave the hard and frozen cruſt of the ground, which cannot ſufficiently yield to it; whether this (I ſay) may produce the clefts we were ſpeaking of, or whether they muſt be derived from ſome other cauſe, not having yet made the experiments I thought upon, to clear the matter one way or other, I do not as yet pretend to determine, but will rather ſubjoin the ſecond obſervation, I purpoſed to mention, of a ſtrange operation of cold upon the ground; and it is afforded us by the *Dutch*, in their often quoted third voyage to *Nova Zembla*; in one place of which they tell us, 'That when they had built them a 'wooden houſe, and were going to ſhut themſelves up in it for the winter, they made 'a great fire, without the houſe, therewith to thaw the ground, that they might ſo 'lay it, *viz.* the wood, about the houſe, that it might be the cloſer; but it was all 'loſt labour, for the earth was ſo hard, and frozen ſo deep into the ground, that 'they could not thaw it, and it would have coſt them too much wood, and therefore 'they were forced to leave off that labour.'

11. AFTER what we have ſaid about the ſtrange effects of cold, in reference to fire, air, water, and earth, we will now proceed to take notice of its effects upon confeſſedly compounded bodies, whether inanimate or living: but of the former ſort of mixed bodies (I mean thoſe, that have not life) it will not be neceſſary to ſay much in this ſection, in regard that we have in many other places, upon ſeveral occaſions, had opportunities to mention already moſt of the particulars, that belong to that head. For we elſewhere take notice, that violent colds would freeze beer, ale, vinegar, oil, common wine, and even ſack, and *Alicant* themſelves. We have likewiſe noted, that the cold may have a notable operation upon wood, bricks, ſtone, veſſels of glaſs, earth, and even pewter, and iron themſelves; to which *Bartholinus*, out of *Janus Munck*'s voyage to *Greenland*, allows us to add veſſels of braſs (though theſe are not immediately broken by the cold, but by the included liquors, which it dilates) and divers ſtrange effects of cold upon inanimate bodies, which it were here troubleſome to recapitulate, may be met with diſperſed in ſeveral places of the preſent hiſtory. Wherefore having only intimated in general, that, though many plants are preſerved by a moderate cold, yet it has been obſerved, that moſt garden-plants are deſtroyed by exceſſive degrees of it, we will paſs on to conſider the effects of cold upon animals; of the many obſervations,

that we have met with among travellers, concerning this ſubject, we ſhall, to avoid prolixity, deliver only the conſiderableſt, and thoſe, that we find atteſted by very credible writers.

12. CAPTAIN *James*, ſpeaking of the laſt of the three differences he makes of cold (namely, that, which he and his company felt in the woods) gives this account of it; (Captain *James*'s voyage, *p.* 64.) ' As for the laſt, it would be ſo extreme, ' that it was not endurable; no clothes were proof againſt it, no motion could ' reſiſt it. It would moreover ſo freeze the hair of our eye-lids, that we could ' not ſee; and I verily believe, that it would have ſtifled a man in a very ' few hours.'

13. *Olearius* giving an account of the air of *Muſcovy*, and eſpecially the capital city of it, ' The cold (ſays he, *Livre* 3. *p. m.* 117.) is there ſo violent, that no furs ' can hinder it, but ſometimes men's noſes and ears, feet and hands will be frozen, ' and all fall off.' He adds, that in the year 1634, when he was there, ' they could ' not go 50 paces without being benumbed with cold, and in danger of loſing ſome ' of their limbs.' And yet to add that remarkable obſervation upon the by, the ſame author, near the ſame place, ſpeaking of *Moſcow*, and the neighbouring provinces diſtinguiſhed from the reſt of that vaſt empire, ſays, (*Livre* 3. 116.) ' that the air is good and healthy, ſo that there one ſcarce ever hears of ' the plague, or any other epidemical diſeaſes.' And he adds, that for that reaſon, when in the year 1654, ' the plague made havock in that great city, ' the thing was very ſurprizing, nothing like it having been ſeen there in the memory ' of man.'

14. OUR already divers times mentioned Engliſh ambaſſador Dr. *Fletcher*, ſpeaking of the cold, that ſometimes happens in *Ruſſia*, witneſſeth thus much of it: ' Divers, (ſays he, *Purchas*, *lib.* 3. *pag.* 415.) not only that travel abroad, but in ' the very markets and ſtreets of their towns, are mortally pinched, and killed ' withal; ſo that you ſhall ſee many drop down in the ſtreets, many travellers brought ' into the towns, ſitting dead and ſtiff in their ſleds. Divers loſe their noſes, the tips ' of their ears, and the balls of their cheeks, their toes, feet, *&c.* Many times, ' when the winter is very hard and extreme, the bears and wolves iſſue by troops out ' of the woods, driven by hunger, and enter the villages, tearing and ravening ' all they can find, ſo that the inhabitants are fain to flee for the ſafeguard ' of their lives.'

15. To deſcend now to obſervations, that do ſomewhat more punctually ſet forth the more particular phænomena of cold, in reference to men's bodies, take the following obſervation: ' The 15th of *March* ſome of their men, that had been ' abroad to kill deer, returned ſo diſabled with cold, which did riſe up in bliſters ' under the ſoles of their feet, and upon their legs, to the bigneſs of walnuts, that ' they could not recover their former eſtate (which was not very well) in a fortnight ' after.' This may be confirmed by that paſſage of the Hollanders, where ſpeaking of their preparing ſpringes to take foxes, they add, (*Purchas*, *pag.* 497.) that ' they ' did it with no ſmall trouble; for that if they ſtayed long without doors, there aroſe ' bliſters upon their faces and ears. We did daily find by experience (ſays Captain ' *James*, *pag.* 64.) that the cold in the woods would freeze our faces, or any part of ' our fleſh, that was bare; but it was not ſo mortifying, *&c*'.

16. THE Dutch, ſpeaking of the pains they were fain to take to dig away the ſnow, that covered the houſe, and choaked up their doors, adds, (*page* 497.) that in that laborious work, ' they were forced to uſe great ſpeed, for they could not long

‘ endure without the houſe, becauſe of the extreme cold, although they wore foxes ſkins ‘ about their heads, and double apparel upon their backs.’

17. THE lately mentioned Captain *James* relates, that in *Charleton* Iſland he was fain to cut the hair of his head ſhort, and ſhave away all the hair of his face, becauſe the icicles, that would be faſtned to it, made it (as he ſpeaks, *page* 56.) become intolerable.

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18. AND he elſewhere relates, that once he and his companions, having been for a little while parted into two companies, ‘ had their faces, hair, and clothes ſo frozen ‘ over, that they could not know each other by their habits, nor (which is a ‘ conſiderable circumſtance, for whoſe ſake chiefly I mention this paſſage) by ‘ their voices.’

19. AND the ſame author gives this account of the death of the gunner of his ſhip, whom he calls a ſtrong-hearted man, and who died before the end of *November*. ‘ He had (ſays our author) a cloſe boarded cabin in the gun-room, which was ‘ very cloſe indeed, and as many clothes on him as was convenient, (for we ‘ wanted no clothes) and a pan with coals of fire continually in his cabin; for ‘ all which warmth, his plaiſter would freeze at his wound, and his bottle of ſack ‘ at his head.’

Purchas, lib. 3. cap. 5. pag. 496.

20. ‘ THE 11th of *December* (ſays *Gerat de Veer*) it was fair weather, and a clear ‘ air, but very cold, which he that felt not would not believe; for our ſhoes froze as ‘ hard as horns upon our feet, and within they were white, ſo that we could not wear ‘ our ſhoes, but were forced to make great pattens, the upper part being ſheeps-‘ ſkins, which we put on over three or four pair of ſocks, and ſo went in them ‘ to keep our feet warm; yea, and the clothes upon our backs where white ‘ over with froſt.’

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Purchas, page 49.

21. WHICH may be ſomewhat confirmed by this paſſage of Captain *James*: ‘ The ‘ clothes on our beds would be covered with hoar froſt, which in this little habitacle ‘ was not far from the fire.’ We might add to all theſe this other paſſage of the often-mentioned *Gerat de Veer*: ‘ The 26th of *December*, it was foul weather, the ‘ wind north-weſt, and it was ſo cold, that we could not warm us, although we uſed ‘ all the means we could with great fires, good ſtore of clothes, and with hot ſtones ‘ and billets laid upon our feet, and upon our bodies, as we lay in our cabins; but ‘ notwithſtanding all this, in the morning our cabins were frozen, *&c.*’ But we ſhall not inſiſt on ſuch paſſages as this laſt recited, becauſe that of the force of cold to repreſs and withſtand the fire we have already delivered as remarkable things, as will be eaſily met with, in approved writers, in the former part of this preſent ſection.

22. I HAVE myſelf met with a knowing and very credible perſon, that related to me of the cold of *Ruſſia*, where he travelled, little leſs ſtrange things, than thoſe I have mentioned out of books; and if I did not want the hiſtorian's name, I ſhould make ſmall difficulty to add, that ſince I made a good progreſs in this preſent ſection, a very learned traveller (though not into cold countries) related to me, upon the occaſion of what I was treating, what he affirmed to have met with in an approved hiſtory of the ſtrange operation of the inclemency of the air upon multitudes of men at once; namely, that about the year (if he rightly remember it) 1498, an army of the Turks making an incurſion into *Poland*, upon their return was ſurprized with ſuch an extremity of cold and of ſnow, that though it were but (if he miſtake not) in *November*, forty thouſand of them (the whole army conſiſting of ſeventy thouſand) periſhed through the extremity upon the place.

23. AMONGST the many relations I have met with of the fatal effects of cold in the northern countries, I took notice, not without a little wonder, as well as trouble, that I could not find, that any of the relators had the curioſity to ſee, what change was made in the internal parts of the bodies ſo deſtroyed, which yet were an inquiry very proper to have been made; but at length the other day an ingenious perſon having ſhewed me a book newly publiſhed in French, containing the deſcription of a Polonian province he calls *Ukrain*, as I was ſkimming it over, with hopes to find ſome obſervations about cold, I lighted on a relation, which, though not ſuch as I deſired, is more than I have any where elſe found; and I take the more notice of it, becauſe that though the very name of this province is ſcarce hitherto known to us in *England*, yet having a while after, by good chance, met with an intelligent Polonian lord, and having enquired of him, whether he had ever been in that country, he both told me, that he had been quartered there, and by his anſwers and relations did countenance divers particulars of it, mentioned by this French officer (named *Monſieur de Beauplan*) who lived long there. This author then, after having taken notice, that this fertile province, though but ſituated in the ſame height of the pole with *Normandy*, is oftentimes ſubject to exceſſive colds, (which circumſtance I mention as a further confirmation of ſomething of the ſame nature delivered in the former ſection) gives an account of two differing effects of this cold upon the bodies of men; the one being a peculiar kind of ſickneſs, the other death.

24. THE firſt, which I remember not to have elſewhere met with, is, that ſometimes, when the natural heat proves ſtrong enough to protect the toes, and cheeks, and ears, and other parts, that are either more remote from the heart, or more tender, from a ſudden mortification; yet unleſs nature be aſſiſted, either by good precautions, or remedies, ſhe cannot hinder the cold from producing in theſe parts cancers as painful as thoſe, which are cauſed by a ſcalding and malignant humour; and which let me ſee (ſays my author) when I was in thoſe countries, that cold was not leſs cutting nor powerful to deſtroy things, than the fire to conſume them. He adds, that the beginning of theſe cancerous ſores is ſo ſmall, that what produces the pain ſcarce equals the bigneſs of a pea, and yet in few days, nay ſometimes in few hours, it ſpreads ſo, as to deſtroy the whole part it invades; which he confirms by the example of two perſons of his acquaintance, who in a trice loſt by congelation the badges of their ſex.

25. As to thoſe, that are killed with cold, our author informs us, that they periſhed by two differing kinds of death. For ſome being not ſufficiently fortified againſt the cold by their own internal heat, not competently armed againſt it by furs, inunctions, and other external means, after having had their hands and feet firſt ſeized by the cold, till they grow paſt feeling it there, the reſt of their bodies are ſo invaded, that they are taken with a (kind of lethargick) drowſineſs, that gives them extreme propenſity to ſleep; which if indulged to, they can no more awake out of, but die inſenſibly. And from this kind of death our author adds, that he was ſeveral times ſnatched by his ſervants, who were more accuſtomed to the cold, and ſeaſonably forced him to awake out of thoſe drowſineſſes, which they knew to be moſt dangerous. And that ſometimes the death by cold is indolent enough, the relations of ſome intelligent acquaintance of mine, who have been in exceeding cold countries, do confirm.

26. BUT the other way, whereby cold deſtroys men, is that, which is the moſt remarkable in our author, and though leſs ſudden is more cruel. For he tells us, that ſometimes the cold ſeizes men's bodies in the reins, and all about the waiſt (and eſpecially horſemen underneath the armour of the back and breaſt) and ſtraitens, as he

ſpeaks, thoſe parts ſo forcibly, that it freezes all the parts of the belly, eſpecially the guts; ſo that though they have keen appetites, they cannot digeſt, or ſo much as retain the lighteſt and eaſieſt aliments, without excepting broths themſelves, but preſently reject them by vomit, with unſpeakable gripings and pains, and ſo continually complaining of their condition, and ſometimes crying out, as if ſomebody were tearing out their bowels, they end their miſerable lives, being often brought, by the violence of their torments, to the brink of madneſs and deſpair, before they come to that of the grave. And our author having ſeen ſome of theſe departed wretches opened, ſays, that they found the greateſt part of their guts black, burnt up, and as it were glewed together; whence he thinks it probable, that, as their bowels came to be ſpoiled and gangrenated, they were forced to thoſe complaints and exclamations; and we may add, that probably upon the ſame cauſe depended thoſe continual vomits of what they eat or drank, the gangrene of the guts hindring the deſcent of excrements downwards, as it often falls out in the true *Iliaca Paſſio*, and the periſtaltick, or the uſual motion of the parts being inverted, as it alſo frequently happens in the ſame diſeaſe. There is no doubt but anatomiſts and phyſicians will think this account very imperfect, but yet I think myſelf beholden to the author for it, becauſe it is not the beſt, but the only, that I have hitherto yet met with of this matter; though I could wiſh it had been much more full and particular, and that he had alſo opened thoſe animals, and eſpecially their brains, that he mentions to have been killed ſuddenly, and without pain, by cold. For ſuch informations (whoſe want, as far as our climate will permit, I have had thoughts of ſupplying upon experiments of other animals) would perhaps ſatisfy me one way or other about a conjecture I have had, and been able to countenance by ſeveral trials upon vegetables and dead animals, about the cauſe of mortifications produced by exceſſive cold.

27. WHAT effects a violent cold may have upon the bodies of other animals than men, I ſcarce find at all taken notice by the writers I have met with, and what I remember upon that ſubject amounts to but few particulars: the French author lately quoted takes notice in general, that the cold in *Ukrain*, as the Polanders call it, is ſometimes ſo great, as to be ſcarce ſupportable by horſes, and ſome other tame beaſts.

28. THIS ſame author alſo mentions a certain four footed-animal called *boback*, which is ſaid to be peculiar to thoſe parts, and hides himſelf under ground in the winter: and having inquired of the lately mentioned Poliſh nobleman concerning this beaſt, he told me, that being in that province he had one preſented him as a rarity, upon an occaſion proper enough to be mentioned here. For ſome of the *Poles* chancing to dig (for ſome purpoſe that I remember not) in a certain retired place, were ſurprized to find under ground an animal not familiar to them; and though this creature was ſo frozen and ſtiff, that they thought it be to ſtark dead, yet when they came to flea it for its ſkin, being awakened by pain, it recovered life again, and was brought as a rarity to the commander, from whom I have the relation.

29. THAT ſome other animals may be frozen till they are ſtiff, and yet recover, I ſhall (ere long) have occaſion to obſerve at the cloſe of the 21ſt ſection. And therefore I ſhall now add but this, that whereas it is a tradition among travellers into northern climates, that both birds and wild beaſts are in icy and ſnowy countries ordinarily turned white, if not at all times, yet at leaſt in the winter by the coldneſs of thoſe gelid climates; I dare neither admit the poſition, as a thing that is true univerſally, nor reject it as a thing that is never ſo. For not now to enquire, whether whiteneſs proceeds from the coldneſs of the country, or from ſome ſettled ſeminary

impreſſion, or from the imagination of the females affected by the vivid whiteneſs of the ſnow, that almoſt all the year long is the conſtant object of their ſight; I find of the voyages I have peruſed, that navigators often mention their meeting with ſtore of white bears and foxes in *Nova Zembla*, and other very northern regions, as alſo their meeting ſometimes with herds of white deer. And in the *Alps*, always covered with ſnow, good authors mention their having met with white partridges; to which purpoſe I remember, that when I was in *Savoy*, and the neighbouring countries, which have mountains almoſt perpetually capped with ſnow, I heard them often talk of a certain white kind of pheaſants to be met with in the upper parts of the mountains, which for the excellency of their taſte were accounted very great delicacies. But on the other ſide, the ſame navigators treating even of the coldeſt climates, ſeem to diſtinguiſh the white bears from others of thoſe parts[*]; and as for a herd of white deer, their colour may proceed from ſeminal impreſſions, ſince here in *England* I have ſeen ſeveral deer of that colour; and though *Greenland* be by ſome degrees nearer to the pole than *Nova Zembla*, yet I have ſeen a live deer brought thence ſomewhat differingly ſhaped from ours, whoſe ſkin was not white, but rather a kind of dun: and to add that upon the by, I took notice, that provident nature, to arm them againſt the cold, had afforded him a coat, that might have paſſed for a fur.

30. Yet theſe two things ſeem remarkable in favour of the efficacy of cold; the one, that in ſeveral cold countries, as particularly *Greenland*, and *Livonia*, even modern deſcribers of them affirm [†], that hares will grow white in winter, and return to their native colour in ſummer; and the other, that though *Charleton Iſland* differ not one degree in latitude from *London*, yet (as the cold is there prodigious, ſo) I remember, that Captain *James* ſomewhere takes notice of his having ſeen there, both divers foxes, that were pied black and white, and white partridges, though he could not catch them. (*Pag.* 46, and *pag.* 89.) But of the whiteneſs of animals I elſewhere treat among other ſubjects, that belong to the hiſtory of colours. And having already been more prolix than I intended in ſetting down the obſervations of others, I think it now time for me to reſume the mention of my own experiments, divers of which, though made before others, that have been already mentioned, X or XII ſections off, I thought fit to reſerve for this place, both for other reaſons, and becauſe this place ſeems proper for experiments, that have a nearer tendency to the hinting or the examining the more general hypotheſis about cold.

## TITLE XX.

*Experiments touching the weight of bodies frozen and unfrozen.*

1. SINCE divers of thoſe ingenious men, that have of late revived and embraced the doctrine of the old Atomiſts, teach us, that water is turned into ice by the introduction of frigorifick corpuſcles, which *Democritus* of old is ſaid to have believed to be cubical (and to which other philoſophers of late have aſſigned other ſhapes indeed, but yet determinate ones) we thought fit, not ſo much for our own ſatisfaction, as for that of others, to try, whether or no a liquor by its increaſe of weight,

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[*] And it is from very northern countries, that we uſually receive very dark coloured furs, and the ſkins as well of black foxes as of white ones.

[†] *Lepores coloris & pellis mutatione anni tempeſtates ſequuntur, ac hiberno tempore albis pilis veſtiti, æſtivis menſibus eoſdem cinereos habent.* Livoniæ nova deſcriptio, pag. 303.

when frozen, would betray any ſubſtantial acceſſion of the corpuſcles of cold, which, according to the Epicurean principles, may, by reaſon of their ſmallneſs, paſs in freely, and in vaſt multitudes, at the pores of other bodies, and even of glaſs; and which, by reaſon of the ſame ſmallneſs, muſt be ſuppoſed exceedingly numerous to be able to arreſt the motions of ſuch multitudes of minute corpuſcles, as muſt go to the making up of any conſiderable quantity of water.

2. AND firſt we made a trial with eggs, of which our notes give us the following account.

3. [WE took a good pair of ſcales and placing them upon a frame (purpoſely made for ſuch experiments, as required, that the things to be weighed ſhould remain long in the ballance) we put into one of theſe a couple of eggs, and having counterpoiſed them with braſs weights, we ſuffered them to continue all night in a turret (built as it had been made for an obſervatory) that the breaking of the eggs, or any ſuch other accidents might not hinder the ſucceſs of our endeavours, (which were to try, whether the corpuſcles of cold, which divers philoſophers ſuppoſe to be the efficients of congelation, would make them any whit heavier:) but we were ſomewhat ſurprized, when the next morning, after a very ſharp night, going up to the turret, we found (the ſcales and frame being in good plight) the eggs to be grown lighter by near four grains.]

THUS far the note.

4. BUT though we afterwards repeated the experiment once or twice (if not oftener) yet having been, by intervening avocations, diverted from regiſtering the circumſtances of the events, I dare not now truſt my memory for any more, than that ſome of the circumſtances ſeemed odd enough, but uncertain, and that I deſiſted from proſecuting the experiment, chiefly for this reaſon, that an increaſe of weight in expoſed eggs was ſcarcely to be hoped for, becauſe it ſeemed probable, that part of the more ſubtile and ſpirituous corpuſcles contained in the egg do continually, by little and little, get away through the pores of the ſkin and ſhell; that ſeeming to be the reaſon, why eggs long kept have uſually within the ſhell a manifeſt, and ſometimes very conſiderable cavity unfilled with either yolk or white; which cavity ſeems to have been left by the receſs of the ſubtile parts we have been mentioning: ſo that although the frigorifick atoms ſhould by their ingreſs add ſome, not altogether inſenſible, weight to the egg, yet that would not, unleſs perhaps in the very nick of time, when the congelation is firſt actually made, be taken notice of, by reaſon of the greater decrement of weight, that proceeds from the avolation of the more ſubtile parts of the egg it ſelf.

5. AND to ſatisfy our ſelves about this matter, we took four hen eggs, and counterpoiſed them carefully in a good pair of ſcales, which were ſuſpended at a frame, that the balance might be kept unſtirred in a quiet room, wherein we had placed it; and ſuffering it to continue there for a pretty while, we obſerved, that though it were winter, and though the room, wherein it ſtood, were deſtitue of a chimney, yet that ſcale, wherein the eggs lay, did almoſt grow manifeſtly lighter; ſo that it was requiſite, from time to time, to take a grain out of the oppoſite ſcale, to reduce the balance to an æquilibrium. And by this means we found the eggs, after ſome time, to have loſt eight grains of their former weight: but how much more they would have loſt, if we had continued the experiment, the need we had of the ſcales kept us from diſcovering.

UPON this occaſion I will add, that I uſed ſome endeavours to ſatisfy myſelf about this inquiry, *viz.* whether eggs being once actually frozen (for thoſe mentioned in the former note, might loſe their weight before they were ſo) and kept in a pair of good ſcales faſtened to a frame in ſome quiet place, well fenced from the ſun, would by the cold of the air, in freezing weather, be kept for any conſiderable time, without a ſenſible diminution of weight: but an unexpected thaw hindered us from ſeeing the ſucceſs of what we deſigned of this nature, both as to eggs, and alſo ſome other bodies: for if the experiment were very carefully tried upon a competent variety of them, it might poſſibly aſſiſt us to gueſs, eſpecially in camphire, and ſome other eaſily exhalable bodies, what intereſt cold may have in ſuppreſſing or diminiſhing the expiration of their effluvia.

7. BUT to return to the weight of bodies frozen and unfrozen, we attempted to diſcover ſomewhat about it by ſeveral ways, according as the differing accommodations, we were furniſhed with, permitted. And of theſe trials I will mention four or five, as well of the leſs, as of the more accurate, as my memory or notes ſupply me with them.

8. ONE of the leſs accurate ways we always imployed to try, whether ice, in which, according to the Atomiſts, great ſtore of theſe corpuſcles muſt be wedged, would not, upon their expulſion or receſs, leave the water lighter than was the ice, was that, which follows; wherein, to haſten the experiment, we mingled a little ſalt. And though we foreſaw, there would be a difficulty from the adheſion of the vapours of the external air to the outſide of the glaſs we were to employ, we thought that inconvenience might be remedied by well wiping off the froſt, or dew, from the outſide of the glaſs, till it were clean and dry: the event of the trial we find ſuccinctly ſet down among our notes as follows. [A ſingle phial ſealed up with ice and ſalt, being wiped dry, and weighed, was found to weigh four ounces four drachms and a half: when it was quite thawed, it was found to weigh ſomewhat more than a grain leſs than its former counterpoiſe.]

BUT more accurate and ſatisfactory trials about this matter, I find thus ſet down in one of my papers:

9. [WE took a phial more thin than thoſe, that are commonly uſed, that, of the aggregate of that and the liquor, the glaſs might make ſo much the leſſer part. This phial was furniſhed with a ſomewhat long neck, which at the flame of the lamp was drawn by degrees ſlenderer and ſlenderer, that being very narrow at the top, it might the more readily and conveniently be ſealed, notwithſtanding the waters being in it: then we almoſt filled it with that liquor, I ſay almoſt, becauſe a competent ſpace ought to be left unfilled, to allow the water, ſwelled by glaciation, room to expand it ſelf. This phial, with the liquor in it, was placed in a mixture of ſnow and ſalt after our uſual manner; and when the glaſs appeared almoſt full of ice, it was taken out, and nimbly cloſed with *Hermes*'s ſeal. Preſently after, this was weighed in a pair of very good ſcales, and the phial together with the contained liquor amounted to ℥v. 38. gr. ß. which yet was not all ice, becauſe theſe things could not be done ſo nimbly, but that ſome of the ice began to thaw, before we were able to diſpatch them quite. The phial thus ſealed being removed, and ſuffered for two or three hours to thaw, when the ice was vaniſhed, we weighed again the ſealed glaſs in the ſame ſcales, and found that it weighed, as before; at leaſt, if there were any difference, it ſeemed, to weigh a little more. But this increment, that amounted not quite to $\frac{1}{4}$ a grain, might eaſily be attributed to ſome difference in the weights and grains themſelves, wherein it is not eaſy to find a perfect exactneſs, or to ſome little unheeded moiſture, that might adhere to ſome part of the phial.]

10. AND becauſe it may be wiſhed, that as the experiment ſhews the weight of ice diſſolved into water, to be the ſame with that of the ſolid ice; ſo we had tried,

whether the weight of water congealed into ice would be the ſame with that of the former fluid water, we will ſubjoin what immediately follows in the ſame paper, in theſe words.

11. [WE took a ſealed phial, very thin, that it might be lighter, but not ſo large as the other, by about a third, as amounting in the lately mentioned ſcales but to ℥iiij. ʒij. gr. 41. when we had ſealed it up with the water in it. This phial we placed, as we had done the other, in a mixture of ſnow and ſalt, freezing it warily, leſt being ſealed it ſhould break; then we removed it into the ſame ſcales, to try, whether it had got any weight by the ſuppoſed ſubingreſſion of the atoms of cold, which many learned men take to be the efficients of congelation; but it either weighed juſt as before, or if there were any difference, it ſeemed to have loſt $\frac{1}{4}$ of a grain. Being ſuffered to thaw, and put into the ſame ſcales again, it weighed juſt as much as it did when frozen, though the weights were numerically the ſame, and about $\frac{1}{8}$ would ſway the ſcales, or at leaſt be ſenſible upon them. But note, that I was careful this laſt time to wipe the outſide of the glaſs with a linen cloth, becauſe I have obſerved, according to what I elſewhere deliver, that, in caſe ice be any thing haſtily thawed, it may produce a dew on the outſide of the glaſs, as I ſuſpected that even the warm air might in ſome meaſure do in this: and if it had not been for this ſuſpicion, ſome adhering dew, that I was thereby enabled to detect and wipe off, before I took the phial into the ſcales, might eaſily have impoſed upon us.

12. THESE trials I preſume may give ſome ſatisfaction about the enquiry, for the reſolving whereof I thought fit to make them.

13. BUT I was alſo deſirous to ſee, whether any difference, as to weight, would be produced by freezing and thawing (if I may uſe thoſe expreſſions in this caſe) iron, ſtone, wood, or the like ſolid and permanent bodies, which I intended to have exactly weighed before and after their being expoſed to the air, and alſo after the froſt was gone, (and all this againſt counterpoiſes not expoſed to ſo great a cold) would diſcover any ſenſible alteration, as to weight, that might ſafely be aſcribed to the cold. And though avocations, and the negligence of one, that we employed, kept us from bringing the matter to ſuch an iſſue as was deſired, yet the trials ſeemed not altogether irrational, ſince we have formerly made it probable (and have ſince met with freſh inſtances to confirm it) that even ſtones, and metals, may reſent ſome change of texture by the operations of ſome degrees of cold. And indeed induced by ſuch conſiderations of that kind, as ſeemed the leaſt doubtful, I remember I ſometime made ſeveral experiments of the weight of ſome metals, and ſtones, both before and after they had been much expoſed to a more vehement cold, than would have ſufficed to turn water into ice; and alſo after they had been, if I may ſo ſpeak, thawed in a warm air. But the paper, in which we regiſtered the events of theſe trials, having been miſlaid, I dare not charge my memory with the particulars. Only, if I miſtake not, one or two of the ſtones ſeemed to have increaſed in weight, after having been buried in our frigorifick mixture, which I was apt to impute to ſome particles of the ice reſolved into water by the ſalt, that was mingled with it, and (being perhaps made more piercing by the ſaline particles aſſociated with them) imbibed into the pores of the ſtone. For I remember, that having procured an experiment, that I then wanted conveniency to try myſelf, to be made by an ingenious perſon, upon a ſtone hard enough to bear a good poliſh, I was by him informed, that the ſtone, by having been kept a while in water, did, though it were afterwards wiped dry, diſcover a manifeſt increaſe of weight: and in confirmation of my conjecture, I ſhall add, that from a ſort of ſtones, that are of a texture cloſe enough to be uſually

poliſhed, I did, as I expected, obtain, by diſtillation, (and that without a naked fire) a conſiderable quantity of an almoſt inſipid liquor, which I ſuſpected to be in good part but water ſoaked into the ſtone, for reaſons, that it is not worth while here to diſcourſe of; the cauſe of my mentioning theſe particulars being, that (I hope) they may make thoſe, that ſhall hereafter try ſuch experiments, cautious how they draw inferences from them, and may invite them to expoſe the bodies, they would make trial of, rather to the cold of the free air in very ſharp weather, (for want of which, we ourſelves could not do what we adviſe) than to artificial glaciations at leaſt, unleſs they be ſo ordered, that nothing that is moiſt come to touch thoſe bodies to be wrought upon.

14. But ſuch trials as theſe newly mentioned, and others of the like kind, we muſt leave to be proſecuted by thoſe, that are furniſhed with accurate ſcales, and leiſure; for want of the latter of which, and ſometimes too of the former, we were fain to give over the purſuit of them: which troubled us the leſs, becauſe thoſe made with the ſealed phials were diligently made; and as for divers others, we made them, as we were ſaying, more to be able to gratify others, than to ſatisfy ourſelves; becauſe though in caſe there ſhould unqueſtionably appear ſome ſenſible increaſe or decrement of weight upon that, which the Atomiſts would call the *acceſſion or expiration* of frigorifick corpuſcles, it would afford a plauſible argument in favour of the Epicurean doctrine, about the generation of ice: yet if no ſuch change of weight ſhould be found upon the freezing or the thawing of the water, or any other body, I doubt whether it may, on the contrary, be ſafely concluded, that the Atomiſts theory of cold is falſe. For poſſibly they may pretend, that the atoms of cold may not have either gravity or levity, or any more than the ſteams of electrical bodies, or the effluvia of the load-ſtone. Nay, though we ſhould admit the frigorifick corpuſcles not to be altogether devoid of gravity, it may yet be ſaid, that when they invade the body they freeze, they expel thence ſome other pre-exiſtent atoms, that may alſo have ſome little weight; and that the frigorifick corpuſcles, that fly, or are driven away, may be ſucceeded by ſome ſuch, when bodies come to be thawed. But of this no more at preſent.

## *Appendix to the XXth Title.*

THE experiments, we recorded in the foregoing ſection, may perchance in this regard prove more uſeful than I was aware of, that they may keep men from being miſled by the contrary accounts, that I find to have been given of the weight of ice, and water, by no obſcure writers. For, to ſpare one of the famouſeſt of the ancients, *Helmont*, in the treatiſe he calls *Gaſs Aquæ*, where he gives an account of the congelation of water; which I confeſs to be unintelligible enough to me, and where he is pleaſed to aſcribe to I know not what extenuation of part of the ſulphur he ſuppoſes to be in water, that levity of ice, which the bubbles, it contains, afford us an intelligible and ready account of, delivers very poſitively this experiment. *Imple* (ſays he, *Num.* 35.) *lagenam vitream & magnam fruſtis glaciei, collum verò claudatur ſigillo Hermetis, id eſt, per vitri ibidem liquationem: ponatur hæc tum lagena in bilance, adjecto pondere in oppoſitum, & videbis, quod propemodum octava ſui parte aqua poſt reſolutam glaciem erit ponderoſior ſeipſa glacie. Quod cum millesies ex eadem aqua fieri poſſit*, &c. Thus far *Helmont*, who in caſe he take *lagena vitrea* in the ordinary acception of the word, would have made us ſome amends for this erroneous account, if he had taught us the way, how he could ſeal ſuch a broad veſſel, as a glaſs flaggon, hermetically. But what has been delivered in the foregoing ſection, will ſufficiently ſhew, what is to be thought of this experiment of *Helmont*. And for further confirmation, we have ſeveral times weighed ice frozen, and reduced to water, without finding any cauſe to doubt, but that *Helmont* was miſtaken. And particularly upon the laſt trial I made of this kind, having filled a wide-mouthed glaſs with ſolid fragments of ice, together with it, amounting to a pound (of which the glaſs alone weighed ſomewhat above five ounces) I whelmed over the mouth of it another flat bottomed glaſs, that if any vapours ſhould aſcend, they might be condenſed into drops, as in the like caſe I had formerly obſerved them to do. And this ice being thawed in a warm room, as no drops were ſeen to ſtick to the inſide of the inverted glaſs, ſo the other glaſs being again put into the ſame ſcales, appeared almoſt exactly of the ſame weight as formerly; whereas the ice alone, that had been diſſolved, amounting to much above eight ounces, according to *Helmont*'s proportion, the weights ſhould have been augmented by a whole ounce at leaſt: and I make little doubt, but that if the experiment had been tried in greater quantities of ice, the event would have been very little, if at all different. But I purpoſely choſe, in the ſtatical experiments about cold, to make my trials in no greater quantities of matter than I have done, becauſe it is very difficult to get ſcales ſtrong enough to weigh, without being injured, much greater weights, and yet be accurate enough to diſcover truly ſuch ſmall differences, as are fit to be taken notice of in ſuch experiments. But to return to *Helmont:* Notwithſtanding all that we have ſaid againſt what he delivers about the weight of ice, yet becauſe I take this inquiſitive chymiſt to have been, in ſpite of all his extravagancies, a benefactor to experimental learning, I am willing to ſuggeſt on his behalf, that poſſibly much of the additional weight he aſcribes to the reſolved ice, may have proceeded from that which would not have been taken notice of by an ordinary experimenter. For (as I not long ſince intimated) I have (ſometimes purpoſely, and ſometimes by chance) by thawing ice in cloſed veſſels ſomewhat haſtily, produced a copious dew on the outſide of the veſſels; which dew, as being made by the condenſed vapours of the ambient air, ought to be wiped off, before the veſſel be put into the ſcales to weigh the melted ice: and is poſſible alſo, that *Helmont* may have erred in the manner of weighing his *Lagena,* whatever he mean by it; it being uſual even for learned men, that are not verſed in ſtaticks, to miſtake in experiments, which require, that things be ſkilfully and nicely weighed. How far this excuſe may be applied to a late * commentator upon *Ariſtotle*'s meteors, who ſays, he tried, that water frozen is heavier than unfrozen; being a ſtranger to that author's writings, I ſhall not conſider: only whereas *Helmont* and he ſeem to agree very little in their affirmations, it will be perhaps more difficult to accord them, than to determine, by the help of our formerly regiſtered experiments, what may be thought of both their relations.

YET I ſhall add on this occaſion, that if I had not deviſed the abovementioned way of freezing water by art in hermetically ſealed glaſſes, I ſhould have found it difficult to reduce, what is affirmed by *Manelphus,* which I then dreamt not of, to an accurate experiment: for though I had imployed a ſealed glaſs, (which I have not heard, that he or any other has yet made uſe of to that purpoſe) yet if I had in that veſſel expoſed the water to be frozen the common way, it is odds (though it be not abſolutely certain) that the water beginning, as it is wont, to congeal at the top, the expanſion of the ſubſequently freezing water would break the glaſs, and ſo ſpoil the experiment. And for the ſame reaſon I have ſometimes in vain attempted to examine the weight of water frozen by nature, according to her wonted method in open phials. And if, inſtead of glaſſes, you make uſe of ſtrong earthen veſſels, there is danger, that ſomething may be imbibed, or adhere to the porous veſſel, and increaſe the weight; and by ſome ſuch way, or by ſome miſtake in weighing, it is very probable *Manelphus* may have been deceived: which I am the more inclined to think, if we ſuppoſe him a ſincere writer, not only becauſe of ſome things I have taken notice of, about congelations made in earthen veſſels, but becauſe, when I have, inſtead of an earthen, made uſe of a metalline pottinger, (both which ſorts of veſſels have in common this inconvenience, that their ponderouſneſs makes them leſs fit for accurate ſcales) there appeared cauſe to ſuſpect, either that our author did not uſe metalline veſſels, or, which I rather ſuſpect, that he wanted ſkill or diligence in weighing. For as I find no intimation of his having employed any peculiar or artificial ſort of veſſels, ſo, if he uſed ſuch as we have newly been ſpeaking of, and had weighed them carefully, I cannot but think, that inſtead of finding the ice heavier than the water it was made of, he would have rather found it lighter. For I remember, that having once expoſed all night a pottinger, almoſt full of common water, to an exceeding ſharp air, and having cauſed it the next morning to be brought me, when the liquor was throughly frozen, I found it to have loſt about 50 grains (if I miſremember not) of its former weight. And though this event were conſonant enough to my conjectures, yet for greater certainty I repeated the experiments another froſty night with this new caution; that the pottinger and water, together with the counterpoiſe, were kept ſuſpended in the ſcales, to be ſure, that no effuſion of any part of the water in carrying it abroad to the open air ſhould be made without being taken notice of: but the next morning (ſomewhat late) the veſſel, with the contained water now congealed, appeared to have loſt about 60 grains; and with the like ſucceſs the trial was reiterated once more, and that in weather ſo ſharp, that I am not apt to think, the water expoſed by *Manelphus* began to freeze ſooner than ours. But the event was not unexpected; for beſides that I conſidered, that in theſe kind of experiments, part of the water, notwithſtanding the exceeding coldneſs of the air, muſt in all likelihood fly away before the ſurface of it began to be congealed, I judge it not improbable, that not only the fluid part, but even that, which was already congealed, might continually loſe ſome of its corpuſcles, and by their receſs loſe alſo ſomewhat of its weight. And leſt theſe conjectures ſhould ſeem too unlikely, it will not be amiſs to add in favour of the firſt of them, that having purpoſely provided a large pewter box, with a cover to ſcrew on it, and having filled it almoſt full of water, (I ſay almoſt, becauſe if the veſſel had been quite full, the congealing cold might have burſt it) and carefully weighed the aggregate of both (which amounted to ℥v. ʒii. gr. 11. whereof the veſſel weighed ℥ii. ʒviß. and gr. 8.) we expoſed the water after the top of the pot was ſcrewed on, to hinder the avolation of it, to the freezing air all night, and the next morning found it frozen from the top to the bottom, though not uniformly and perfectly, but found not one grain difference betwixt its preſent and its former weight. And as for the ſecond conjecture newly propoſed, though it may ſeem ſomewhat ſtrange, yet it is confirmable by this experiment, that having placed divers lumps of ſolid ice in a pottinger, which together with them weighed a pound, conſiſting of 16℥. and having expoſed theſe things in the ſame ſcales, wherein they were weighed, to the free air, on a very froſty night, we found the ice to have loſt the next morning 24 grains of its weight; and the weather continuing ſo cold, that it froze hard all day long in the ſhade, I gave order to have it kept out of the ſun in the ſame ſcales, during all that time, and a good part of the following night, and then weighing it the ſecond time, found, that the whole decrement of weight did now amount to five grains above two drachms, though the weight of the ice, without the pottinger, were but about ſeven ounces: and when we had kept about 13 ounces of ice, in a very froſty night, expoſed to the cold air, it had loſt, as early as the next morning, a good deal above two drachms of its former weight. But theſe ſtatical obſervations have perhaps already but too much ſwelled this Appendix.

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* —*Hinc gelidam congelatamque aquam graviorem eſſe non congelata expertus eſt Jo. Manelphus.* Com. in 4. Meteor. Ariſtot. inquit Tho. Bartholinus de Nivis uſu, cap. 12.

## TITLE XXI.

### *Promiſcuous experiments and obſervations concerning cold.*

1. I HOPE it will not be imagined, that I have ſuch narrow thoughts of the ſubject I treat of, Cold, as to believe, that I have comprized under thoſe few titles, prefixed to the Sections of this hiſtorical treatiſe, all the particulars, that I knew to belong to ſo comprehenſive a theme; as would readily appear, if I thought it convenient to inſert here the ſcheme of articles of inquiry, that I drew up to direct my ſelf, what inquiries and experiments to make. But though there were divers of thoſe heads, to which I could ſay ſo little, that I judged it improper to aſſign them diſtinct titles, becauſe, as to ſome of them, I had not time and opportunity to make thoſe trials, which, if I had not wanted thoſe requiſites, might have been made, even here in *England*; and becauſe alſo, as to more of them, I conceived my ſelf unable to produce, in this temperate climate, ſo ſtrong and durable a cold, as ſeemed neceſſary to make the trials, that might be referred to them, ſucceed ſo far, as to ſatisfy my doubts, either affirmatively, or negatively: Though, I ſay, theſe and ſome other conſiderations kept me from increaſing the number of the titles, among which I have diſtributed the experiments and obſervations, that make up the foregoing part of this treatiſe, yet ſince divers particulars have occurred to me, which though they ſeem not properly reducible to the foregoing titles, do yet belong to the ſubject and deſign of this treatiſe, I think it fit to annex them in this place, and without any other order than that, wherein they ſhall happen to occur to me, throw them into this one ſection; together with ſome looſe experiments, and divers relations, that I have met with among navigators and authors, that have travelled into the northern climates, touching cold, not forbearing to inſert promiſcuouſly among them ſome few *paralipomena*, which, if they had ſeaſonably come to my hands, or into my mind, might have had a more proper place among the foregoing ſections, or have compoſed a title by themſelves. Wherefore though the obſervations will not be altogether unaccompanied with experiments, yet for the reaſons above intimated, much the greater part of what is to be delivered under this title, will conſiſt of collections out of voyages, in which the ſtrange things mentioned being ſuch, as we cannot examine by our own trials, I can equitably be thought anſwerable for the truth of nothing but the citations.

2. I REMEMBER I tried, at ſeveral times, divers experiments, to diſcover, whether or no congelation would by conſtriction of the pores of bodies, or vitiating their texture, or arreſting the motion of their parts, hinder them from emitting thoſe effluvia, that we call odours; but the regiſter of theſe obſervations, being unhappily loſt in one of my late removes, I dare add but theſe few, wherein I have no cauſe to diſtruſt my memory.

3. I DID, in the months of *December* and *January*, at ſeveral times gather differing ſorts of flowers in froſty weather; but in moſt, when they were freſhly gathered, and haſtily ſmelt to, I could ſcarce perceive any ſenſible ſmell: whether it were, that the cauſes above hinted hindered the expiration of the odoriferous ſteams, or that the cold had ſome undiſcerned influence upon the organ of ſmelling, which made the ſenſe

more dull, or that the ſame cold kept the alimental juice of the flowers from riſing in ſuch plenty, and abounding ſo much with ſpirituous parts, as was uſual at the more friendly ſeaſon of the year: and this ſeemed the more likely to be one reaſon of the phænomenon, becauſe moſt of the flowers were flaggy, and as it were, ready to wither, and becauſe alſo a primroſe, that was vigorous and freſh in its kind, had an odour, that was manifeſtly (and it will eaſily be believed, that it was not ſtrongly) ſweet, and genuine.

4. I took alſo, about an ounce, by gueſs, of roſe-water, and putting it into a ſmall phial, after I had ſmelt to it, it was expoſed to freeze in the open air; and when it began to have ice in it, I then ſmelt to it again, but found not the perfume conſiderably, if ſo much as manifeſtly abated: and laſtly, having ſuffered it to continue in the air, that was then very ſharp, 'till it was quite frozen, and diſcovered no liquor, when the phial was turned upſide down, the ice notwithſtanding was not deſtitute of a graceful and genuine ſcent, though it ſeemed ſomewhat faint; but after the ice was reduced to water again, the fragrancy appeared conſiderable. But on this occaſion it will not be improper to ſubjoin this caution, that care muſt be had, in trials of this nature, to make one's eſtimate betimes; for if a man ſhould ſtay too long about it, there is danger, that the warmth of one's breath and face may relax the pores, or thaw the ſurface of the ice, that is held near his noſe, and both free and excite the corpuſcles of ſmell, that are impriſoned there, that ſo inſtead of ice, he may ſmell a liquor. The reaſonableneſs of which advertiſement may be juſtified by an experiment, that I am about to annex. For being pretty well confirmed by the caſual and unwilling obſervations of one of my friends, curious in making ſweet water, that even liquors more eaſy to be ſpoilt than roſe-water would not have their fragrancy deſtroyed, though perhaps impaired, nor ſo much as their odours for the time quite impriſoned and ſuppreſſed by congelation; and this appearing congruous to what I formerly noted of the effluviums, that may, by the decrement of weight, be gathered to iſſue from ice itſelf, I thought it worth while to try, whether ſtinking liquors would not be more altered by congelation, than odoriferous ones. And accordingly having procured ſome rain-water, that had been kept in a tub, 'till it ſtunk ſo ſtrongly, that I could hardly endure it near my noſe, I cauſed a pottinger full of it to be expoſed all night to a very ſharp air; and examining it the next morning, when it was all turned into ice, neither I, nor ſome others, to whom it was offered, could perceive any ſtink at all in it. And having in another place, but with as ſtinking water, repeated the experiment, when the pottinger was the next morning brought to my bed's ſide, I found it to ſmell abominably; whereupon gueſſing, that this difference proceeded from ſome thaw made by the warmth of the room in the ſuperficial parts of the ice, I found it to be ſo indeed, partly by the help of the light, which diſcovered a little liquor upon the ice, and partly by expoſing the veſſel with that liquor in it to the cold air again, by whoſe operations an ice was produced, that was perfectly inodorous: and I remember, that one of theſe parcels of ice being thawed, ſeemed to be leſs ſtinking than before [*] it had been frozen; and if I had not been diverted, I ſhould have tried, whether this ice, that did not omit odours, would emit, like other ice, effluvia, diſcoverable by the ſcales: for whether the ice would

[*] If it had not been for the negligence or miſtake of one, that I ordered in my abſence, to freeze and thaw the ſame water, divers times one after another, I might have added the ſucceſs of that experiment, which I was ſorry to miſs of, becauſe it might poſſibly have afforded an uſeful hint about a way to correct ſtinking waters, in ſome climates or ſeaſons.

loſe of its weight, which ſeemed the more probable, or would not, the event may afford a not inconſiderable hint.

5. It is a thing not only remarkable, but ſcarce credible, that though the cold has ſuch ſtrange and tragical effects at *Moſcow*, and elſewhere in cold countries, as we have formerly mentioned, eſpecially a little after the beginning of the 18th and ſomewhere in the 19th ſection; yet this happens to the Ruſſians and Livonians themſelves, who, not only by living in ſuch a country, muſt be accuſtomed to bitter colds, but who, to harden themſelves to the cold, have uſed themſelves, and thereby brought themſelves to be able to paſs to a great degree of cold, from no leſs a degree of heat, without any viſible prejudice to their healths. For I remember, that having inquired of a virtuoſo of unqueſtionable credit, whether the report of our merchants, concerning this ſtrange cuſtom of the Muſcovites and Livonians, were certainly true, he aſſured me, that it was ſo, at leaſt as to the Livonians, among whom, being in their country, he had known it practiſed. And the ſame was affirmed to me by an ingenious perſon, a doctor of divinity, that had occaſion ſome years ſince to make a journey to *Moſcow*. And the tradition is abundantly confirmed by *Olearius*, whoſe teſtimony we ſhall ſubjoin, becauſe this ſeems one of the eminenteſt, and leaſt credible inſtances, that we have yet met with of the ſtrange power, that cuſtom may have, even upon the bodies of men. ‘ It is a wonderful thing, ſays he, to ſee how far thoſe ‘ bodies (ſpeaking of the Ruſſians, that are accuſtomed and hardened to the cold) ‘ can endure heat, and how when it makes them ready to faint, they go out of their ‘ ſtoves ſtark naked, both men and women, and caſt themſelves into cold water, or ‘ cauſe it to be poured upon their bodies, and even in winter wallow in the ſnow.’ To which paſſage our author adds, from his own obſervation, particular examples of the truth of what he delivers.

Olearius, livre 3. pag. 168.

6. I had ſeveral years ſince, the curioſity to try, whether there were any truth in that tradition, which is confidently affirmed, (and experience by ſome is pretended for it) that the beams of the moon are cold; but though I were not able to find any ſuch matter, either by the united beams of the moon, or by the ſame beams concentred by ſuch burning-glaſſes as I then had; yet having ſome years after furniſhed my ſelf with a large and extraordinary good metalline concave, I reſolved to try whether thoſe beams were not only devoid of cold, but alſo ſomewhat warmiſh, ſince they are the ſun-beams, though reflected from the moon. And we ſee, that his beams, though reflected from glaſſes not ſhaped for burning, may yet produce ſome not inſenſible degree of warmth. But notwithſtanding my care to make my trials in clear weather, when the moon was about the full, and, if I miſremember not, with a weather-glaſs, I could not perceive by any concentration of the lunar beams, no not upon a black object, that her light did produce any ſenſible degree, either of cold or heat; but perhaps others, with very large glaſſes, may be more ſucceſsful in their trials.

7. On this occaſion I ſhall add, that meeting the other day in a bookſeller's ſhop with the works of the learned phyſician *Sanctorius* (whom I look upon as an inquiſitive man, conſidering when and where he lived) a picture drew my eyes to take off an experiment, whereby he thinks to evince the light of the moon to be conſiderably hot; which he ſays, he tried by a burning-glaſs, through which the moon's light being caſt upon the ball of a common weather-glaſs, the water was thereby depreſſed a good way, as appeared to many of his diſciples, amidſt whom the obſervation was made. But though this may invite me, when opportunity ſhall ſerve, to repeat my trials, yet I muſt till then ſuſpend my aſſent to his concluſion. For my burning-glaſs was much better, than by the narrative his ſeems to have been; and my trials were

perhaps at leaſt as carefully and impartially made, as his experiment, in which this may probably have impoſed upon him; that performing the experiment, a company of his ſcholars, whilſt they ſtood round about his thermoſcope, and ſtooped (as in likelihood their curioſity made them to do) to ſee by ſo dim a light the event of the experiment, the unheeded warmth of their breath and bodies might, unawares to *Sanctorius*, ſomewhat affect the air included in the weather-glaſs, and by rarifying it, cauſe that depreſſion of the water, which he aſcribed to the moon-beams. But becauſe this is a conjecture, I intend, if God permit, to repeat the experiment, when I ſhall have opportunity to do it with a more tender weather-glaſs, than I had by me, when I made my former obſervations.

## *To the* XIth TITLE.

BY the unſucceſsfulneſs of the former attempts made with an iron inſtrument, I was invited, eſpecially being at another place, where I was unfurniſhed with ſuch hollow iron balls, as are mentioned *num.* 10. to ſubſtitute the following experiment. I cauſed a ſkilful ſmith to take a piſtol-barrel, gueſſed to be of about two foot in length, and of a proportionable bore; and when he had, by riveting in a piece of iron, exactly ſtopped the touch-hole, I cauſed him to fit to the noſe of the barrel a ſcrew, to go as cloſe as well he could make it: and then having filled it to the very top with water, I cauſed the ſcrew to be thruſt in (which could not be done without the effuſion of ſome of the water) as forcibly as the party I imployed was able to do it, that the water, dilated by congelation, might not either drive out the ſcrew, or get between it and the top of the barrel. And having then ſuſpended this barrel in a perpendicular poſture in the free air, in a very cold night, which then unexpectedly happened, and gave me the opportunity of making the trial, I found the next morning, that the intumeſcent water had thruſt out a great part of the ſcrew, notwithſtanding, that, to fill up intervals, I had oiled it before; and was got out betwixt the remaining part of it, and the barrel, as appeared by ſome ice, that was got out, and ſtuck round about the ſcrew. Wherefore, the bitter cold continuing one day longer, I did the next night cauſe the intervals, that might be left betwixt the male and female ſcrews, to be filled up with melted bees wax, which I preſumed would keep the ſcrew from being turned by the water: and having in other points proceeded as formerly, I found the next morning that the ſcrew held, as I deſired, and the preceding night having been exceeding bitter, the cold had ſo forcibly congealed, and expanded the water, that it burſt the iron barrel ſomewhat near the top, and made a conſiderable and oblique crack in it, about which a pretty quantity of ice appeared to ſtick; beſides that, there were three or four other flaws, at ſome of which ſmaller quantities of water appeared to have got out. At the ſame time, that I beſpoke this iron barrel of the ſmith, I ordered him to get me a braſs one filled up after the ſame manner, to make the experiment the more ſatisfactory. But though he could not procure it, yet the ſucceſs was not unwelcome, becauſe it was manifeſt, that there were cracks in the iron in one place conſpicuous, and in others eaſily diſcoverable, by blowing into the barrel, and putting on the outſide of the ſuſpected parts, either ſpittle or ſome fit liquor, whoſe agitation plainly diſcloſed the egreſs of the wind; and there appeared ſmall cauſe to doubt, but that theſe cracks were produced by the operation of the cold; ſince not only the ſmith was a ſkilful man in his trade, and one, that I uſed to imploy about inſtruments, and alſo the barrel had been ſometimes kept many hours filled with water, without appearing other than very ſtanch: but, which is the conſiderableſt circumſtance, the night before, the froſt, as I lately noted, was not able to make the water break out at any of theſe clefts, though it were able to force it ſelf a way out at the ſcrew, in ſpight of all the care we had taken to make it go cloſe. I have only this circumſtance to add about this matter, that when by thawing one part of the ice, ſome pieces of the reſt were got out of the barrel, all I took notice of appeared to be full enough of bubbles, but yet ſuch as ſeemed leſſer than ordinary, whether they were ſo by chance, or were determined to be ſo, by the reſiſtance or compreſſion, which the freezing water found upon its endeavouring to expand its ſelf in the barrel.

### *Appendix to the* XVIIth *Title.*

LONG ſince the writing of the foregoing ſection, meeting with a paſſage in *Bartholinus*, where he vouches *Cabæus* for the experiment of congealing water (without limiting it to any ſeaſon of the year) by putting ſalt-petre into it, and ſhaking it ſtrongly, I was thereby confirmed, that I was not miſtaken, in ſuppoſing, that *Gaſſendus* (mentioned in the former ſection) did not exclude that corporal and viſible nitre out of the number of the grand efficients of congelation. For *Cabæus* having publiſhed his comment upon *Ariſtotle*'s meteors (whence this experiment is taken by *Bartholinus*) before *Gaſſendus* publiſhed this book, it is probable, that he as well as others borrowed the experiment from him; and *Cabæus*, as *Bartholinus* quotes him, preſcribes the putting the ſalt-petre itſelf into water, which being a while put into a briſk motion, will, after ſome agitation, not only refrigerate that water, but bring it to a true and proper congelation.

WHEREFORE ſuſpecting, that this relation, wherein *Bartholinus* ſays, he will believe him without an oath, may have given riſe to the opinions and affirmations of thoſe ingenious writers, that have ſince aſcribed ſuch wonderful coldneſs to nitre, and finding in *Bartholinus*, that *Cabæus*'s proportion betwixt the nitre and the water, was that of 35 to 100, that is, almoſt as one to three, I thought it very well worth while to make trial of an experiment, which ſeemed to me little leſs unlikely than conſiderable.

I TOOK then a pound of good ſalt-petre, and near three pound of common water (to obſerve the more narrowly *Cabæus*'s proportion) theſe being put into a large new pipkin, were kept conſtantly and nimbly ſtirred about, ſometimes by me, ſometimes by one or other of the domeſticks relieving one another, when they were weary; but though the mixture was with a kind of broad glaſs ſpattle kept in a briſk motion, that for the moſt part was after the manner of a whirl-pool, and ſometimes a more confuſed agitation, and though we kept it thus ſtirring for almoſt an hour and a half, till we ſaw no likelihood of effecting any thing by trying our ſelves any further, yet not only we could not perceive that any atom of true ice was produced; whereas, according to our authors, we might have expected a true and perfect congelation of all, or the greateſt part of the water, but we did not find, that there was ſo much as any freezing of the vapours on the outſide of the veſſel; and for this reaſon we thought fit about the ſame time, to try the experiments by another kind of agitation, and mixing two ounces of ſalt-petre with about ſix of water, in a conveniently ſized phial, we did ſeveral of us ſucceſſively vehemently ſhake the phial to and fro, till we were almoſt tired; but neither this way was there produced the leaſt ice within the glaſs, or the leaſt congelation of the vapours of the air on the outſide of it. It is true, that when ſo great a proportion of ſalt-petre began to be diſſolved in the pipkin, the water had a ſenſible increaſe of coldneſs, which afterwards ſeemed to diminiſh, when once the nitre was diſſolved; but not to mention, that (if I much miſtake not) we have obſerved the water to be refrigerated, when, upon the diſſolution of common ſalt, multitudes of actually cold and ſolid corpuſcles came to be every way diſperſed through it; this coldneſs produced by the nitre was very far ſhort of the degree requiſite to congelation: for to ſatisfy myſelf, that my ſenſe did not miſ-inform me, I took a good ſealed weather-glaſs of about ten or twelve inches long, and immerſing it into the cold mixture of nitre and water, I obſerved the tincted ſpirit of wine in the ſtem to deſcend not inconſiderably; and when I perceived that degree of cold to have wrought its effect, I removed the thermoſcope into a phial filled with common water; about which I had cauſed to be placed a mixture of beaten ice and ſalt, to refrigerate the contained water, in which the ball of the inſtrument being placed, the ſpirit of wine haſtily deſcended two or three inches below that place, at which it ſtood, when it was removed out of the nitrous ſolution: and, for further ſatisfaction, removing the thermoſcope once again into that ſolution, the ſpirit of wine in the ſtem was haſtily impelled up, as if the bubble had been put into warm water. And, once more, the weather-glaſs being removed into the formerly mentioned refrigerated water, the tincted liquor began to fall down haſtily again, and, within a while, ſubſided almoſt into the bubble; whereupon, to avoid injuring the inſtrument, we thought fit to take it out. So that, upon the whole matter, if the learned *Cabæus* were not deluded by miſtaking ſome cryſtals of nitre (which I have obſerved eaſily to ſhoot again in water, that has been glutted with it) for true and proper ice, I cannot but wonder at his aſſertion, and muſt take the liberty to think my ſelf warranted, by ſo many harmonious trials, as I have found unfavourable to the ſuppoſed ſupremeneſs of cold in ſalt-petre, to retain my former opinion about it, till more ſucceſsful experiments withdraw me from it.

It is a received tradition, among the watermen and many others, that the rivers, if not ponds alſo, are frozen firſt at the bottom, and begin to thaw there. But though I find this opinion to be in requeſt, not only among Engliſh watermen, but among the French too, yet I think it may be very warrantably queſtioned: for it is evident, in waters we expoſe to freeze in large veſſels, that the congelations begin at the ſurface, where the liquor is contiguous to the air; and thence, as the cold continues to prevail, the ice increaſes, and thickens downwards: and therefore we ſee, that frogs retire themſelves, in froſty weather, to the bottom of ditches, whence I have had many of them taken out, very briſk and vigorous, from under the thick ice that covered the water. And I have been informed by an obſerving perſon, that at leaſt in ſome places, it is uſual, in winter, for ſhoals of fiſhes to retire to thoſe depths of the ſea, if not of rivers alſo, where they are not to be found in ſummer. Beſides, if rivers were frozen at the bottom, we muſt very frequently meet, in the emergent pieces of ice, the ſhapes of thoſe irregular cavities and protuberances, that are often to be found in the uneven ſoils, over which rivers take their courſe; whereas, generally, thoſe emergent pieces of ice are flat, as thoſe flakes, that are generated on the ſurface of the water. Moreover, if even deep rivers freeze firſt at the bottom, why ſhould not very many ſprings and wells freeze firſt at the bottom too: the contrary of which neverthleſs is obvious to be obſerved. In confirmation of all which, we may make uſe of what we formerly noted, (in the ſection of the *Primum Frigidum)* about the practice of the maſters of the French ſalt-works, who, by overflowing the banks and cauſeways all the winter, keep them from being ſpoiled by the froſt; which could not be done, if the waters, they ſtand under, froze as well at the bottom, as at the top.

But, I find, that that, which deceives our watermen, is, that they often obſerve flakes of ice to aſcend from the bottom of rivers, to the top; and indeed it often happens, that, after the hard froſt has continued a while, theſe emergent pieces of ice do very much contribute to the freezing over of rivers. For, coming, in ſome of the narrower parts of them, to be ſtopped by the ſuperficial ice, that reaches on each ſide of the river, a good way from the banks towards the middle, thoſe flat icy bodies are eaſily cemented by the violence of the cold, and, by the help of the contiguous water, to one another, and by degrees ſtreightning, and at length choaking up the paſſage, they give a ſtop to the other flakes of ice, that either emerging from the bottom, or looſened from the banks of the river, are carried down the ſtream towards them; and theſe being alſo by the ſame cold, cemented to the reſt, the river is at length quite frozen over. And the reaſon, why ſo many flakes of ice come from the bottom of the river, ſeems to be, that, after the water has been frozen all along near the banks, either the warmth of the ſun by day, or ſome of thoſe many caſualties, that may perform ſuch a thing, does by thawing the ground, or otherwiſe, looſen many pieces of that ice together with the earth, ſtones, *&c.* that they adhered to, from the more ſtable parts of the banks; and theſe heavy bodies do, by their weight, carry down with them the ice they are faſtened to; but then the water at the bottom of the river being warm, in compariſon of the air, in froſty weather, (ſince that even common water is ſo, we have manifeſted by experience, where we ſhew how much ſooner ice will be diſſolved in water, than thawed in air) the diſperſed ice is by degrees ſo wrought upon, that thoſe parts, by which it held to the ſtones, earth, or other heavy bodies, being reſolved, the remaining ice being much lighter, bulk for bulk, than water, gets looſe, and ſtraightway emerges, and may perhaps carry up with it divers ſtones and clods of earth, that may yet happen to ſtick to it, or be incloſed in it, the ſight of which perſuades the waterman, that the flakes of ice were generated at the bottom of the river; whereas a large piece of ice may carry up, and ſupport bodies of that kind, of a great bigneſs, in caſe the ice it ſelf be proportionably great, ſo that the aggregate of the ice, and heavy bodies, exceed not the weight of an equal bulk of water. On which occaſion I remember, that Captain *James Hall*, in a voyage extant in *Purchas*, relates, that, upon a large piece of ice in the ſea, they found a great ſtone, which they judged to be three hundred pound weight. But, of the tradition of the watermen we ſhall ſay no more, than that this hath been diſcourſed, but upon no great information, though the beſt we could procure; ſo that, for further ſatisfaction, it were to be deſired, that, either by ſending down a diver, or by letting down ſome inſtrument fit to feel (if I may ſo ſpeak) the bottom of rivers with, and to try, whether ice, if he met with any, be looſe from, or uniformly coherent to the ground, and alſo bring up parcels of whatever ſtuff it meets with there, the matter were, by competent experiments, put out of doubt.

WE took a ſealed weather-glaſs, furniſhed with ſpirit of wine, and though not above ten inches long in all, yet ſenſible enough; and, having cauſed a hole to be made in the cover of a box, juſt wide enough for the ſmall end of the glaſs to be thruſt in at, we inverted the thermometer, ſo that the ball of it reſted upon the cover of a box, and the pipe pointed directly downwards. Then we placed about the ball a little beaten ice and ſalt, and obſerved, whether, according to our expectation, the tincted ſpirit, that reached to the middle of the pipe, or thereabouts, would be retracted upon the refrigeration of the liquor in the ball; and accordingly the ſpirit did in a very few minutes aſcend in that ſhort pipe above an inch higher than a mark, whereby we took notice of its former ſtation, and would perhaps have aſcended much more, if the application of the frigorifick mixture had been continued; by which, and another ſucceeding experiment to the ſame purpoſe, it ſeems that the condenſation of liquors by cold, is not always affected by their proper gravity only, which ordinarily may be ſufficient to make the parts fall cloſer together: but whether in our caſe, the contraction be aſſiſted by ſome little tenacity in the liquor, or by the ſpring of ſome little aerial, or other ſpirituous and elaſtick particles, from which the inſtrument was not perfectly freed, when it was ſealed up, or which happened to be generated within it afterwards, will be, among other things, more properly inquired into in another place, where we may have occaſion to make uſe of this experiment.

There is a famous tradition, that in *Muſcovy*, and ſome other cold countries, it is uſual out of ponds and rivers to take up good numbers of ſwallows incloſed in pieces of ice; and that the benumbed birds upon the thawing of the ice in a warm room, will come to themſelves again, and fly about amazedly for a while, but not long ſurvive ſo great and ſudden a change. I have in another treatiſe already ſaid ſomewhat about this tradition, and therefore ſhall now ſay no more of it, than theſe two things: firſt, that I ſince was aſſured by a perſon of honour, that is very curious, and was commanded by a (many ways) great prince to enquire out the truth of it, when he was in ſome of thoſe countries, where the thing is ſaid to be familiar enough, and that the eminenteſt and ſobereſt perſons he could aſk affirmed the thing to be true: but, (ſecondly) having lately enquired about this matter of a knowing perſon of quality, that was born and bred in *Poland*, he anſwered me, that in the parts, where he lived, it was a very general and unqueſtionable opinion, that ſwallows often hid themſeves all the winter under water in ponds and lakes, and ſedgy places, and that the fiſhermen, when having broken the ice, they caſt their nets for fiſh, to draw them up benumbed, but not dead, ſo that they quickly in ſtoves recover their wings, but ſeldom after that prolong their lives. But as for their being taken up in ice, he told me, he had not heard of it; though I ſee not, why in caſe they commit themſelves to ſhallow waters, as thoſe of ponds and ſedgy places often are, a ſharp laſting froſt may not ſometimes reach them. And therefore that, which left me the greateſt ſcruple about this tradition, is, that this gentleman, notwithſtanding his curioſity, could not affirm, that ever he himſelf had ſeen any example of the thing he related.

But I will take this occaſion to add, that having a mind in froſty weather to try ſome anatomical experiments about frogs, one, that I imployed breaking in a ditch ſome ice, that was very thick, and of which he was to bring me a quantity, found in the water, that was under the ice, good ſtore of frogs (beſides ſome toads) which I found to be very lively, and divers of which I kept for certain uſes a good while after.

To confirm, and to add ſome paralipomena unto what I have delivered in the ſecond, and in the twentieth titles, about the froſt's getting into hard and ſolid bodies, I ſhall here ſubjoin ſome particulars there omitted, which I have learned partly from experiments, and partly from perſons worthy of credit, whom I purpoſely conſulted about this matter.

And firſt, as to the freezing of wood, we have ſometimes tried it by purpoſely expoſing partly other wood, and partly branches cut off from growing trees, to an intenſe degree of cold, by which the wood ſeemed in one night to be for ſome little depth manifeſtly enough invaded by the froſt. But a domeſtick of mine having a little while ſince had occaſion to fell an old apple-tree, on a day, that had been preceded by a fortnight's bitter froſt, came and informed me, that he found, that the froſt had evidently pierced into the very middle of it, though it were about a foot in diameter. And an experienced artificer, whoſe head and hand were much imployed about the building of great men's houſes, told me, that he had often ſeen here in *England* pieces of timber itſelf manifeſtly frozen, and rendered exceeding difficult to be ſawed, the froſt alſo appearing by evident ſigns to continue in the ſaw-duſt. And therefore it will be the leſs ſtrange, if in *Poland* the effects of cold upon wood be more conſpicuous. For a learned native aſſured me, that in his country it was uſual to have wood frozen ſo hard, that the hatchets would not cut it, but rebound from it; and that it was very uſual to hear in the night a great many loud cracks, almoſt like the reports of piſtols, of the ſhingles or wooden tiles, wherewith in many places they cover their houſes inſtead of ſlate; and this (as I purpoſely aſked) when the weather was dry, and exceſſively cold. When I likewiſe enquired about the thawing of wood, he told me, he had ſeveral times ſeen pieces of timber, which having been thoroughly frozen in the air, did, when brought into rooms, made warm by ſtoves, become covered with a kind of hoar froſt, and made them look white, and that though his bow (which he ſhewed me) were very ſtrong and tough, as being made not of wood, but horn, and other cloſe materials, it would be ſo changed by the froſt, that unleſs ſpecial care were had in the thawing of it, it would break.

THAT marl and chalk, and other leſs ſolid terreſtrial concretions, will be ſhattered by ſtrong and durable froſts, is obſerved by huſbandmen, who thereby find it the better fitted to manure their land; the texture of thoſe bodies, during whoſe intireneſs the parts moſt proper to feed graſs and corn, are more locked up, being by congelation in great part diſſolved; but that true and ſolid ſtones, wont to be imployed in noble and durable buildings, ſhould be ſpoiled by the froſt, will perhaps to moſt readers ſeem very improbable. And therefore I ſhall here add what I have learned by inquiry of the ingenioueſt and moſt experienced maſon I have met with, becauſe it may not only ſurprize moſt readers, but prove an uſeful obſervation to him. Having then enquired of this tradeſman, whether he did not find, that ſome free ſtone, a name vulgarly known, would not be ſpoiled by the froſt, he told me, that he had often obſerved both free ſtone and harder ſtones than that, to be exceedingly ſpoiled by the froſt, and reduced to crack or ſcale off, to the blemiſhing and prejudice of the houſes, that are built of them. But becauſe it may be objected againſt this, that experience ſhews us, that divers of the ſtatelieſt fabricks in *England* have theſe ſtones for their chief materials, and it endure very well the inclemencies of the air; the reply may be, that the difference may not conſiſt in the peculiar natures of the ſtones imployed, but in the ſeveral ſeaſons in which the ſame kind of ſtones are digged out of the quarry. For if they be digged up, when the cold weather is already come in, and imployed in building the ſame winter, they will, upon very hard froſts, be apt to be ſhattered or ſcale; but if they be digged early in the ſummer, ſuffered to lie expoſed to the ſun and air, during all the heat of the ſummer, theſe ſeaſoned ſtones, if I may ſo call them, may out-laſt many ſharp winters unimpaired. It ſeems to me worth trying, whether during their inſolation, if that term may be allowed me, there do not, by the operation of the heat and air upon them, exhale a certain unripe mineral, ſap or moiſture (whoſe receſs may perhaps be diſcovered by weight) which, if it remain in the ſtone, may, by very piercing froſts, be congealed almoſt like the ſap in timber-trees, and ſhatter the texture of the ſtone; which agrees well with what was told me by an underſtanding perſon, that is maſter of a great glaſs-houſe, of whom having purpoſely inquired, whether he did not find, that his great earthen pots, which are made up with as little water as is poſſible, and are deſervedly famous for their durable texture, had not that texture altered and impaired by very piercing froſts; he aſſured me, that if he did not take care to keep the froſt (as they ſpeak) from getting into them, thoſe great and ſolid veſſels, wherein he uſed to keep his glaſs in fuſion, would, in the fire, ſcale or crack (and perhaps fly) and become unſerviceable no leſs than ſome weeks ſooner, than if they had never been impaired by the froſt. And when I inquired, whether alſo glaſs itſelf would not be much prejudiced thereby, he affirmed to me, that oftentimes in very hard froſts many glaſſes, that had continued entire for many weeks (for that circumſtance I was ſollicitous to aſk about) would as it were of their own accord crack with loud noiſes. But whatever prove to be the iſſue of ſuch trials, it will not be amiſs to confirm the phænomenon itſelf, by the teſtimony of an illiterate but very experienced French author, who, on a certain occaſion, tells us, (as I alſo take notice in another * treatiſe) 'That he knows the 'ſtones of the mountains of *Ardenne* (famous enough in *France)* are harder than 'marble, and yet the inhabitants of that country do not draw them out of the quarry 'in winter, becauſe they are ſubject to the froſt. And it has been divers times 'ſeen, that upon thaws, the rocks, without being cut, have fallen down and 'killed many.'

* Of the imperfection of Phyſicks. Maſtre Bernard Paliſſy.

But it may yet ſeem far more unlikely, that froſts ſhould get into metals themſelves, and yet having aſked the newly-mentioned Polonian, whether he had obſerved any thing of that kind; he anſwered, that he had often by drawing out his ſword and pulling out his piſtols, when he had been long in the field, and came into a hot room, found them quickly almoſt whitened over, by a kind of ſmall hoar froſt. But whether this were, as he conceived, any thing, that was drawn out of the ſteel, and ſettled on the ſurface of it, I want circumſtances enough to make me willing to determine. But if we will credit *Olaus Magnus*, it muſt be confeſſed, that conſiderably thick pieces of iron and ſteel itſelf will, in the northern regions, be rendered ſo brittle by the extreme froſt, that they are fain to temper their inſtruments after a peculiar manner: his words, which being remarkable I forbear to alter, are theſe; *Videntur præterea ferrei ligones certa ratione fabricati, quia his ſpiſſa atque indurata glacies cæteris inſtrumentis ferreis non cedens faciliùs infringitur, dum aliæ ſecures chalybe permixtæ, in vehementi frigore ad ſolum glaciei vel virentis arboris ictum inſtar vitri rumpuntur, ubi ligones prædicti ſive ferreæ haſtæ fortiſſimi manent.* Which teſtimony, notwithſtanding what ſome have written to this author's diſparagement, does not ſeem to me at all incredible. For I remember, that even here in *England* I have had the curioſity to cauſe trials to be made in very froſty weather, whereby, if an expert ſmith I then uſed to employ, did not *gratis* deceive me in the irons I imployed, that metal may by ſuch degrees of cold, as even our climate is capable of, be rendered exceeding brittle, as he ſeveral times affirmed to me, that there are ſome kinds of iron, which he could hammer, and turn, as they phraſe it, cold in open weather, which yet in very hard froſts would become ſo brittle, as by the ſame way of working eaſily to break, if not to fly aſunder. And this he affirmed both of iron and ſteel; of which latter metal another very ſkilful workman, whom I alſo conſulted, certified the like; but though this diſagreed not with trials purpoſely made on iron rods, as they had informed me, yet preſuming, that in ſuch a nice piece of work as a ſpring, ſome further ſatisfaction about this matter might be obtained, I inquired of a very dexterous artificer, that was ſkilled in making ſprings for others, whether or no he found a neceſſity of giving ſprings another temper in very froſty weather, than at other ſeaſons; and he anſwered me, that in ſuch weather, if he gave his ſprings the ſame temper, that he did in mild and open air, they would be very apt to break. And therefore in very ſharp ſeaſons he uſed to take them down lower, as they ſpeak, that is, give them a ſofter temper than at other times; which, as it makes it probable, that the cold may have a conſiderable operation upon bodies, upon which moſt men would not ſuſpect it to have one; ſo that diſcovery may afford a hint, that may poſſibly reach further than we are yet aware of, touching the intereſt, that cold may have in many of the phænomena of nature.

I SHOULD here ſubjoin, that in proſecution of what is delivered in the XXth ſection about the weight of ſolid bodies, that I there wiſhed might be expoſed to a congealing air, I did cauſe ſome trials of that kind to be made in a very froſty night, eſpecially with bricks; but ſomething, that happened to the only ſcales I then had fit for ſuch an experiment, made me doubt, whether ſome little increaſe of weight, that ſeemed to be gained by congelation, were to be relied upon, though there did not appear any hoar froſt, or other thing outwardly adhering, to which the effect could be aſcribed.

IT is a tradition, which the ſchools and others have received with great veneration from their maſter *Ariſtotle*, that hot water would ſooner freeze than cold: but I do not much wonder, that the learned *Cabæus*, as I find him quoted by *Bartholinus*, ſhould contradict this tradition, though he be himſelf a commentator upon that book of *Ariſtotle*, wherein it is delivered. For I could never ſatisfy myſelf, that there is (at leaſt with our water, and in our climate) any truth in the aſſertion, though I have made trial of it more ways than one; but it may very well ſuffice to mention a few of the plaineſt and eaſieſt trials, with whoſe ſucceſs I am well ſatisfied as to the main, as the reader alſo will, I doubt not, be; though not having, for want of health, been able to have ſo immediate an inſpection of theſe, as of the reſt of my experiments, I was fain to truſt the watchfulneſs of my ſervants (whom I was careful to ſend out often) to bring me word, how long after the firſt freezing of the cold water, it was before the other began to be congealed.

WE took then three pottingers, as near of a ſize as we could; and the one we filled almoſt to the top with cold water, the other with water, that had been boiled before, and was moderately cooled again, and the third with hot water: theſe three veſſels were expoſed together in the ſame place to the freezing air.

IN the entry of one of the trials, I find, that being all three put out at half an hour after eight of the clock, the pottinger, that contained the cold liquor, began to freeze at $\frac{1}{4}$ after ten.

THAT, which contained the water heated and cooled again, began to freeze $\frac{3}{4}$ paſt ten.

AND that, which contained the hot water, at half an hour after eleven, and ſomewhat better. So that though all froze within the compaſs of two hours, yet the cold water began this time to freeze an hour and $\frac{1}{4}$ ſooner than the hot.

THESE pottingers were earthen, but I elſewhere made the trial of others of metal, and there alſo the cold water began to freeze, both before that, which had been heated and cooled again, and long before the hot.

ANOTHER time I meaſured out the water by ſpoonfuls into pottingers (not having then by me any fit ſcales to weigh it) to be the more ſure, that the quantities of water ſhould not be conſiderably unequal, and then alſo the cold water froze a conſiderable while before the hot.

BUT my uſual jealouſy in the making nice experiments tempting me to enquire, whether the water in ſome of the former trials had not been heated in a ſtone bottle, nor a ſkillet, it was confeſſed, that it was ſo, but that the bottle uſed to contain nothing but beer, and had been waſhed before hand: and though I did not think, that the bottle could have any conſiderable influence on the experiment; yet leſt it ſhould be ſuſpected, that the ſcalding water might have imbibed ſome ſpirituous parts remaining yet among the minute dregs of beer in the pores of the bottle, for the greater ſecurity I cauſed the water to be heated in a ſkillet; and becauſe in one of the trials made in a village, where we had not choice of pottingers, the cold water chanced to be put into one, that afterwards ſeemed leſs than that wherein the hot was expoſed, I did this very day repeat the experiment, by putting the cold water into a ſomewhat larger pottinger, heating the other water in a ſkillet, and the event of the trial is this;

That the cold water being put out with the reſt, at $\frac{3}{4}$ after 6, began to freeze ſomewhat before $\frac{1}{2}$ after 7.

The water heated and cooled again began to freeze $\frac{1}{4}$ after 7. And having theſe frozen waters a little while by me, I ſent in, for my own further ſatisfaction, for the hot water, and found it not to be, in the leaſt, frozen at half a quarter after eight. So that ſuppoſing it to continue half a quarter of an hour longer before the beginning of its congelation *, it was twice as long ere it began to freeze, as the cold water had been.

* As it afterwards did at the leaſt.

By which we may ſee, how well beſtowed their labour hath been, that have puzzled themſelves and others, to give the reaſon of a phænomenon, which perhaps with half the pains they might have found to be but chimerical.

I have been the more circumſtantial in ſetting down theſe trials, that I may expreſs a civility to ſo famous a philoſopher as *Ariſtotle*; and alſo becauſe artificial congelations, which we can commonly beſt command, and which we have the ofteneſt uſed about our other experiments, are not ſo proper for this. For having formerly had the curioſity to take two pipes of glaſs made of the ſame cylinder, that they might be of equal bore, and having ſealed each of them at one end, and having filled both to the ſame height, and then ſtirred them to and fro together in a mixture of beaten ice, water and ſalt, (which mixture I make uſe of for the effecting ſudden congelations) I found both waters to freeze too quickly to make a notable diſparity in the length of times, that they remained uncongealed: and we will not, on this occaſion, omit one phænomenon afforded us by theſe trials, becauſe it may admoniſh men, how cautious they ought to be in making nice experiments. For having once made the formerly mentioned trial, with glaſs pipes, that were but ſlender (as not exceeding the bigneſs of a man's fore-finger) and having for greater caution put the hot water firſt into one glaſs, and then into another, we found one time, that the hot water froze firſt, and wondering at it, we examined the glaſſes, and perceiving one of them to be more conical or acuminated, where it had been ſealed up, than the other, it ſeemed probable, and afterwards appeared true, that the water in this accuminated part, being ſuddenly frozen by reaſon of the ſlenderneſs of the glaſs there, promoted and accelerated the congelation of the reſt; ſo that whether it were the cold or the hot water, that was put into that pipe, it would thereby gain a manifeſt advantage.

In the foregoing experiments (made in pottingers) I made uſe not only of cold and hot water, but of water that had been heated and cooled again, though not reduced to its full priſtine coolneſs, to prevent the objections of ſome, that might pretend, that ſuch water would have frozen ſooner than cold, which yet would not ſolve the common opinion which ſpecifies not ſuch water.

## *POSTSCRIPT.*

AND it ſeems, that ſuch cautions, as I have been mentioning, are not altogether uſeleſs. For accidentally caſting my eye upon the *Circulus Piſanus* of *Berigardus* upon *Ariſtotle*'s meteors, I ſomewhat wondered to find, that an author, who is looked upon to be a great adverſary of *Ariſtotle*, except in his dangerous and ill-grounded conceit of the eternity of the world, and ſome other erroneous opinions, does yet endeavour to juſtify *Ariſtotle* by affirming, that this experiment will ſucceed, if by heated water we underſtand that, which having been heated, is ſuffered to cool again, till it be reduced to the temper of other water, which was not heated. For this refrigerated water, he ſays, he has found to congeal much ſooner than the other water: but this I confeſs I am very unapt to believe. For having divers times cauſed cold water to be expoſed to the air in froſty weather, with that, which had been heated and cooled again, and having ſet ſometimes one of my domeſticks, ſometimes another, to watch them, the events did very much diſfavour the aſſertion of our author, though care was had of the circumſtances moſt conſiderable in ſuch an experiment, as the matter, ſize and ſhape of the veſſels; the equal degree of cold in the two ſeveral parcels of water (into both which I ſometimes dipped my finger to judge of them before they were expoſed) and the place, in which they were put both together to be frozen. But for further ſatisfaction, we elſewhere took two pottingers, bought purpoſely for the making of experiments, of the ſame ſize and ſhape, and in the ſame ſhop: one of theſe we almoſt filled with cold water out of a glaſs, wherein we marked, how high that water reached, that by filling the ſame glaſs to the ſame height with the refrigerated water, we might be able to meaſure out the ſame quantity into the other pottinger. This done, I appointed one, whoſe care I had no reaſon to diſtruſt, to examine the tempers of theſe ſeveral waters, with a more than ordinarily ſenſible weather-glaſs, as a far ſafer criterion, than the bare touch, to judge of the coldneſs of liquors. Theſe being reduced to the ſame temper, were expoſed to a very ſharp air, and there watched by the perſon, whom (being not well, and unable to ſupport ſuch weather my ſelf) I appointed to attend the experiment, and he, according to direction, finding them begin to freeze, as it were at the very ſame time, brought me in the two pottingers, in each of which I ſaw the beginnings, and but the beginnings of congelation, where the upper ſurfaces of the waters were contiguous to the containing veſſels. So that having made this experiment with much greater exactneſs than probably *Berigardus* did, or, for want of ſuch inſtruments as I uſed, could make it, I cannot but ſuſpect, ſuppoſing the common waters, he and I uſed, to be of the ſame nature, that he was either negligent or over-ſeen in affirming, that heated and refrigerated water will cool ſo much ſooner [*]. And as I am not convinced by experience, that it will freeze ſooner at all, ſo till he have better made out the reaſon he ſeems to give of the phænomenon, I muſt queſtion, whether he rightly aſcribe after *Cabæus* (if I much miſremember not) the congelation of water to a certain coagulum, diſtinct from the cold ſpirits, that plentifully mingle with the water, which coagulum it ſeems (for his ſtyle is not wont to be very perſpicuous) that he would have to conſiſt of certain dry corpuſcles, no leſs neceſſary to conglaciate water, than runnet to curdle milk: and for what this author ſays [†], that he muſt have employed boiling or ſcalding water, who affirms it to be leſs congealable than other, that miſtake may be ſufficiently diſproved by the ſeveral above recited trials, wherein we found water, moderately refrigerated, to freeze much later than cold. And whereas *Berigardus* intimates, that the perſon, whoſoever he be, that he diſſents from, does unſkilfully ſuppoſe warm ſalt-water to be the leſs diſpoſed to congelation for being ſalt, our author is therein alſo miſtaken; for though it be true, what he alledges, that ſalt outwardly applied promotes the congelation of water, yet that, diſſolved in water, has a contrary effect, may appear by the familiar obſervation, that ſea-water is more difficult to be congealed than freſh water. And to ſhew, that it is not a property of ſea-water, but a water impregnated with common ſalt, I have ſeveral times tried, that a ſtrong ſolution of ſuch ſalt in ordinary water, will not at all be congealed by the being expoſed to the air, even in very ſharp froſts; as may be eaſily collected from ſome of the experiments mentioned in the former part of this book. Another particular there is (about the uſe of alum in reference to freezing) in this often-cited paſſage of *Berigardus*, which I might here examine, if my haſte and my indiſpoſedneſs to ingage in a controverſy of ſmall moment, did not injoin me to defer it till a fitter occaſion.

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[*] *Quare ferventem aquam adhibuiſſe oportet qui aſſerit eam eſſe minus gelabilem, præcipuè ſalſam,* pag. 571.

[†] *Tam cito illa congelabat, ut eximirem ex eo cruſtam unam aut alteram antequam non calefacta vel leviſſime concreviſſet,* pag. 572.

Here the poſtſcript ends.

To confirm the power aſcribed in the ſixth ſection to cold, as to the long preſervation of bodies from corruption, it will not be amiſs to add theſe two remarkable paſſages, the latter of which affords a good inſtance of the improvement, that may be made of ſome degrees of cold to the uſes of human life.

The firſt obſervation is afforded us by ſome of our country-men, in a voyage extant in *Purchas*, where the writer of it ſpeaks thus, of the Samojeds, whoſe country he viſited: 'Their dead they bury on the ſide of the hills, where they live (which is 'commonly on ſome ſmall iſlands) making a pile of ſtones over them, yet not ſo 'cloſe, but that we might ſee the dead body, the air being ſo piercing, that it 'keepeth them from much ſtinking ſavour: ſo likewiſe I have ſeen their dogs buried 'in the ſame manner.'

Purchas, lib. 4. cap. 19. pag. 844.

The other obſervation is given us in the deſcription of *Ireland* (made by one that viſited it) to be met with in the ſame *Purchas*'s collections, where among other things he gives us this account; which, if I miſtake not, I have had confirmed by others, of their ſtrange way of ordering and preſerving their fiſh. 'Having taken them, they 'pluck out the bones, and lay up their bowels, and make fat or oil of them. They 'heap up their fiſh in the open air; and the purity of the air is ſuch there, 'that they are hardened only with the wind and ſun, without ſalt, better 'ſurely than if they were corned with ſalt. And if they kill any beaſt, they 'preſerve the fleſh without ſtink or putrefaction, without ſalt, hardened only with 'the wind.'

Lib. 3. cap. 22.

I know not, whether it will be worth while to add to the fifth and ſixth numbers of the ſeventh title, that, for further confirmation of our opinion, that it is not nature's abhorrency of a vacuum, but the diſtenſion of the water, that breaks glaſſes, when the contained liquors come to be congealed, I did on ſet purpoſe fill ſeveral phials (ſome at one time, and ſome at another) to the lower parts of their necks (moſt of which were purpoſely made long) with common water, and though they were all left unſtopped, that the external air might come in freely to them; yet not only one of them, that I ſtirred up and down in a mixture of beaten ice, ſalt, and water, was haſtily broken upon the congelation of the contained water, but ſeveral others, that were expoſed to be frozen more leiſurely by the cold air only, were likewiſe broken to pieces, by the expanſion of the freezing water, as appeared both by the gaping cracks, and alſo by this, that the ice was conſiderably riſen in the necks above the water's former ſtations, which had been noted by marks before; and if it had been more eaſy for the included water to make it ſelf room, either by ſtretching the glaſs, or (rather) heaving the ſuperficial ice congealed at firſt in the neck, or by both thoſe ways together, than to break the veſſel, the phial would probably have remained intire.

I SAY probably, becauſe I am not ſure, that there may not ſometimes intervene, in theſe experiments, ſomewhat, that may need further obſervation and inquiring. For as it ſeems, that what I have been lately ſaying may be confirmed by an unſtopped phial, which was expoſed at the ſame time to congelation, with this ſucceſs, that without breaking the phial the water was frozen, and the ice in the neck impelled up a good way above the height, at which the liquor reſted before it began to congeal; ſo, on the other ſide, I remember, that I have ſometimes a good ſtore of liquor frozen in a phial, without breaking the glaſs, though a phial were ſtopped: as if the difference, that I have on other occaſions obſerved betwixt glaſſes, whereof ſome are very brittle, and others more apt to yield, might have an influence on ſuch experiments, or that ſome peculiar ſoftneſs, or other property of the ice, that afforded me my obſervation, or elſe ſome other thing not yet taken notice of, were able to vary their ſucceſs.

IN confirmation of what is delivered in the ſeventh ſection, about the expanſion of water by freezing, I ſhall add, that having cauſed ſome ſtrong glaſs-bottles of a not inconſiderable bigneſs to be filled with a congealable liquor, excepting the necks, which were filled with ſallet-oil, I obſerved, that in a ſomewhat long, and very ſharp froſt, the contained water was ſo far expanded by congelation, that it not only thruſt up the corks, but the cold having taken away the defluency of the oil, that liquor together with the water, that could no longer be contained in the cavities of the glaſſes, being, as it ſeemed, frozen as faſt as it was thruſt out of the neck, there appeared quite above the upper part of the bottles, cylinders of divers inches in height, conſiſting partly of concreted oil, and partly of congealed water, having on their tops the corks, that had been raiſed by them.

IT is a tradition very current among us, that when ponds or rivers are frozen over, unleſs the ice be ſeaſonably broken in ſeveral places, the fiſhes will die for want of air [*]. And I find this tradition to be more general, than, before I made particular enquiry into it, I knew of. For *Olaus Magnus* mentions it more than once, without at all queſtioning the truth of it, but rather, as if the general practice of the northern nations to break in divers places their frozen ponds and rivers, were grounded upon the certainty of it. In the twentieth book (which treats of fiſhes) after having ſpoken of the reaſons, why the northern fiſhermen employ ſo much pains and induſtry to fiſh under the ice; and having ſaid among other things, that the nature of the fiſh exacts it, he adds this reaſon, that, [†] ***Niſi glacie perforata reſpiracula ſuſciperent, quotquot in flumine vel ſtagno verſantur, ſubito morerentur.*** Another paſſage of the ſame author, and taken likewiſe out of the ſame (20th) book, you may meet with in the margin, though in another place he ſeems to intimate another, and not an abſurd, reaſon of the death of fiſhes in winter; where advertiſing the reader, that ponds and lakes did generally begin to freeze in [‡] *October*, he adds, that fiſhes are uſually found ſuffocated, when the thaw comes, where veins (or ſprings) of living water do not enter: by which paſſage he ſeems to make the want of ſhifted water co-operate to the ſuffocation of the fiſhes. And to the ſame purpoſe I ſhall now add, that having enquired of a learned native, that had lived about *Cracovia*, (whoſe territory is ſaid to abound much in ponds) whether the Polanders alſo uſed the ſame cuſtom; he anſwered me, that they did, and that ſometimes in larger ponds they were careful to break the ice in eight or ten ſeveral places, to make ſo many, either vents or air-holes, for the preſervation (as they ſuppoſed) of the fiſh. And when I inquired of the often-mentioned Ruſſian emperor's phyſician, whether in *Muſcovy* the froſt killed the fiſh in the ponds, in caſe the ice were not broken to give them air: he anſwered, that in ordinary ponds it were not to be doubted, but that in great lakes he could not tell, becauſe the fiſhermen uſed to break many great holes in the ice for the taking of the fiſh. For at each of theſe holes they thruſt in a net, and all theſe nets are drawn up together in one great breach made in ſome convenient place near the middle of the reſt.

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[*] *Volentes igitur piſcari ſub glacie duo magna foramina, latitudine* 8. *vel.* 10. *pedum centum & quinquaginta vel* 200. *paſſibus à ſe invicem directa diſtantia, aperiunt, inter quæ* 30 *vel* 40 *minora foramina, latitudine unius pedis & ſemis, ab utroque latere diſtantia* 30. *pedum intermedia conſtituunt, tum per ea, &c.* Olai Mag. lib. 20.

[†] *Olaus Mag. Titulo, De curſu glaciali, pro piſcibus. Quæ* (Anguillæ) *ſi totaliter glacie conſtrictæ fuerint, ſimul omnes reſpiraculum ab aëre non habentes pariter ſuffocatæ moriuntur.*

[‡] *Præmittendum eſt quod generaliter omnes lacus & ſtagnales aquæ in menſe Octobri incipiunt congelari, glacieſque aucto frigore in pleriſque locis tantum condenſari, ut ubi venæ lacu & ſtagno viventis aquæ non intrant, piſces ſuffocati tempore reſolutionis glaciei inſpiciantur; verum ne hæc ſuffocatio tam diſpendioſa fiat, diligentiâ piſcatorum continue glacies ipſa perfringitur, ne congeletur.* Olai Magni, lib. 1. Titulo de tranſitu glaciali, *&c.*

It appears then, that the tradition is general enough; but whether it be well grounded enough, I dare not determine, either affirmatively or negatively, till trial have been made in ponds with more of deſign or of curioſity, and watchfulneſs, than I have known hitherto done; men ſeeming to have acquieſced in the tradition without examining it, and to have been more careful, not to omit what is generally believed neceſſary to the preſervation of fiſh, than to try, whether they would eſcape without. Wherefore, though, for aught I know, the tradition may prove true, yet to induce men not to think it certain, till experience has duly convinced them of it, I ſhall repreſent, that as much as I have in other treatiſes manifeſted how neceſſary air is to animals; yet whether fiſhes may not live, either without air, or without any more of it, than they may find interſperſed in the water they ſwim in, has not yet, that I know of, been ſufficiently proved. For what we have attempted of that nature, in our pneumatical engine, whether it be ſatisfactory or not, is not yet divulged. And I remember not to have hitherto met with any writer, (except *Olaus* be conſtrued to intimate ſo much) that affirms upon his own obſervation, that the want of breaking ice in ponds has deſtroyed all the fiſh. Beſides, that poſſibly in frozen ponds, there may be other reaſons of the death of fiſhes, that there are killed (if any ſtore of them be ſo) by very ſharp froſt. For who knows what the locking up of ſome kinds of ſubterraneal ſteams, that are wont freely to aſcend through water unfrozen, may do to vitiate and infect the unventilated water, and make it noxious to the fiſhes, that live in it? perhaps alſo the excrementitious ſteams, that inſenſibly iſſue out of the bodies of fiſhes themſelves, may, by being penned up by the ice, contribute, in ſome caſes, to the vitiating of the water, at leaſt in reference to ſome ſort of fiſhes. For being deſirous to learn from a perſon curious of the ways of preſerving and tranſporting fiſh, whether ſome fiſhes would not quickly languiſh, grow ſick, and ſometimes die outright, if the water they ſwam in were not often ſhifted, he aſſured me, that ſome kinds of them would: and it has not yet, that I hear of, been tried, whether or no, though ponds ſeldom freeze to the bottom, yet the water, that remains under the ice (in which itſelf ſome fiſhes may be now and then intercepted) may not, even whilſt it continues uncongealed, admit a degree of cold, that though not great enough to turn water into ice, may yet be great enough, when it continues very long, to deſtroy fiſhes, though not immediately, yet within a leſs ſpace of time, than that, during which the ſurface of the pond continues frozen. But it is not worth while to be ſolicitous about conjectures of cauſes, till we are ſure of the truth of the phænomenon; and theſe things are propoſed not ſo much to confute the tradition, we have been ſpeaking of, as to bring it to a trial, which, having no opportunities to make in ponds, I endeavoured, as well this winter as formerly, to obtain what information I could from trials made in ſmall veſſels, with the few fiſhes I was able to procure. And I ſhall ſubjoin moſt of theſe trials, not becauſe I think them very conſiderable, but becauſe they are, for aught I know, the only attempts of the kind, that have yet been made.

To ſatisfy myſelf, whether the ice's denying acceſs to the air was that, which deſtroyed fiſhes in frozen ponds, I thought upon this expedient; I procured a glaſs veſſel with a large belly, and a long neck, but ſo ſlender, that it was only wide enough for the body of the fiſhes to paſs through: and then having filled the veſſel with ſome live gudgeons, and a good quantity of water, the neck of it was made to paſs through a hole, that was left, or made for it in the midſt of a metalline plate, or wooden trencher, which could deſcend no lower than the neck, becauſe of the inferiour part of the glaſs, that would not ſuffer it, and which ſerved to ſupport a mixture of ice (or ſnow) and ſalt, which was applied round about the extant neck of the glaſs. By this contrivance I propoſed to myſelf a double advantage: the firſt, that, whereas in broad veſſels it is not always ſo eaſy, as one would think, to be ſure, that the ſurface of the water is quite frozen over in every part; by this way I could eaſily ſatisfy myſelf, by inverting the glaſs, and obſerving, that the ice had ſo exactly choaked up and ſtopt the neck, that no drop of water could get out, nor any bubble of air get in, and yet the fiſhes had liberty enough to play in the ſubjacent water. The other conveniency was, that the frigorifick mixture being applied to the neck, no water was congealed, or extremely refrigerated, but that, which was contained in the neck; ſo that there ſeemed no cauſe to ſuſpect, that in caſe the fiſhes, thus debarred of air, ſhould not be able to live in the water, it was rather cold, than want of air, that killed them. But though not having then been able, by reaſon of a remove, to proſecute theſe trials to the utmoſt, nor to regiſter all the circumſtances, I ſhall not lay much weight upon it; yet I remember, that the included fiſhes continued long enough alive, to make me ſhrewdly ſuſpect the truth of the vulgar tradition.

ANOTHER time being deſtitute of the conveniency of ſuch glaſſes, I cauſed ſome of the ſame kind of fiſhes to be put into a broad and flat earthen veſſel, with not much more water, than ſufficed perfectly to cover them; and having expoſed them all night to a very intenſe degree of cold, I found the next morning, that ſome hours after day, they were alive, and ſeemed not to have been much prejudiced by the cold, or excluſion of air. It is true, that there was a very large moveable bubble under the ice; but that ſeemed to have been generated by the air, or ſome analogous ſubſtance, emitted out of the gills or bodies of the fiſhes themſelves: for, that the ſurface of the water was exactly frozen over (which does not in ſuch trials happen ſo often, as one would think) I found, by being able to hold the veſſel quite inverted, without loſing one drop of water. And that this large bubble might poſſibly proceed from the fiſhes themſelves, I was induced to ſuſpect, becauſe having at different ſeaſons of the year, for divers purpoſes, kept ſeveral ſorts of fiſhes, and particularly gudgeons, for many days in glaſs veſſels, to ſatisfy myſelf about ſome phænomena I had a mind to obſerve, I have often, by watching them, ſeen them lift up their mouths above the ſurface of the water, and ſeem to gape and take in air, and afterwards let go under water out of their mouths and gills divers bubbles, which ſeemed to be portions of the air they had taken in, perhaps a little altered in their bodies. And particularly in lampreys (of which odd ſort of fiſhes I elſewhere make mention) I have, with pleaſure, both obſerved and ſhewed to ingenious men, that being taken out of the water into the air, and then held under water again, they very manifeſtly appeared to

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ſqueeze out, and that not without ſome force, at thoſe ſeveral little holes, which are commonly miſtaken for their eyes, numerous and conſpicuous bubbles of air, which they ſeemed to have taken in at their mouths, if not alſo at thoſe holes. But of theſe matters, a fitter occaſion may perhaps invite me to ſay more. To return now to our gudgeons, I ſhall add, that to ſatisfy myſelf further, what cold and want of air they may be brought to ſupport, I expoſed a couple of them in a baſon, to an exceeding bitter night; and though the next day I found the ice frozen in the veſſel to a great thickneſs, and one of the fiſhes frozen up in it, there remaining a little water unfrozen, the other fiſh appeared through the ice to move to and fro; and the ice being afterwards partly thawed, and partly broken, not only that fiſh was found lively enough, but the other, which I alone judged not to be quite dead, though, when the ice was broke, it lay moveleſs, did, in a few minutes, ſo far recover, as to tow after it (if I may ſo ſpeak) a good piece, into which his tail remained yet inſerted. And though one of theſe, and ſome other gudgeons, that had been already weakened by long keeping, were once more expoſed in the baſon to the froſt and ſuffered to lie there, till they were frozen up; yet the ice being broken, in which they were incloſed, though their bodies were ſtiff and crooked, and ſeemed to be ſtark dead, lying in the water with their bellies upwards, yet one of them quickly recovered, and the other not very long after began to ſhew manifeſt ſigns of life, though he could not in many hours after ſo far recover, as to ſwim with his back upwards. It is true, that theſe fiſhes did not long ſurvive; but of that, two or three, not improbable reaſons, might be given, if it were worth while to name here any other than this, that the ice, they had been frozen up in, or the violence, that was offered them by the fragments of it, when it was broken, had wounded them, as was manifeſt enough by ſome hurts, that appeared upon their bodies; yet ſome other gudgeons were irrecoverably frozen to death, by being kept incloſed in ice, during (if I miſremember not the time) three days. And as for other animals, I cauſed a couple of frogs to be artificially frozen in a wide-mouthed glaſs, furniſhed with a convenient quantity of water: but though they ſeemed at firſt incloſed in ice, yet looking nearer, I found, that about each of them there remained a little turbid liquor unfrozen, as if it had been kept ſo by ſome expirations from their bodies. Wherefore cauſing either the ſame, or two others, (for I do not punctually remember that circumſtance) to be carefully frozen, and for a conſiderable while, I found, that notwithſtanding the ice, into which moſt part of the water was reduced, not only one of them before the ice was broken appeared to be perfectly alive, but the other, that was moveleſs and ſtiff, and lying with the belly upwards in a baſon of cold water, whereinto it was caſt, did in a very few minutes begin to ſwim about in it. I ſhould have made more trials at leaſt, if not alſo more ſatisfactory ones, if I could have had fiſhes, and veſſels, and cold weather at command: but upon the whole matter, though the tradition, we have been examining, may perhaps have ſomething of truth in it, yet it ſeems to deſerve to be further inquired into, both in reference to the truth of the matter of fact, *the death of fiſhes in frozen ponds and rivers*, and in reference to the cauſe, whereto that effect is imputed.

I MET with an odd paſſage in Captain *James*'s voyage, which, if it had been circumſtantially enough ſet down, might prove of moment in reference to the weight of bodies frozen and unfrozen; and therefore, though I would not build any thing on it, yet I ſhall not omit it. ‘ The ninth (ſays he, pag. 82.) we hoiſted our beer and ‘ cyder, and made a raft of it, faſtning it to our ſhoar-anchor. The beer and cyder ‘ ſunk preſently to the ground; which was nothing ſtrange to us, for that any wood

' or pipe-ſtaves, that had lain under the ice all winter, would alſo ſink down ſo ſoon ' as ever it was heaved over board.'

ABOUT the duration of ice I forgot, through haſte, to add a relation of Captain *James*'s, whereby it may appear, that though wine abounds with very ſpirituous and nimble parts, whence it reſiſts congelation far more than water, yet if even this liquor came once to be congealed, the ice made of it may be very durable. For he ſets down in his journal, that when he came to his ſhip again, he found a butt of wine, that had been all the winter in the upper deck, ' to continue as yet all firm frozen, ' though it were then the month of *May*.' (*pag*. 47.)

Purchas, lib. 3. cap. 5. pag. 487.

WHEN I treated of the great proportion in ſome pieces of ice, that were aground, inſtead of taking notice of a great piece of ice mentioned by *Gerat de Veer*, to be 52 fathom deep, the paſſage, that was to be tranſcribed, was this other, hard by, which contains two examples of towers of ice, where the extant part reached upwards. ' We ſaw (ſays he) another great piece of ice not far from us, lying faſt ' in the ſea, that was as ſharp above, as if it had been a tower; whereunto we ' rowed, and caſting out our lead, we found that it lay 20 fathom faſt on ' the ground under the water, and 12 fathom above the water.—We rowed ' to another piece of ice, and caſt out our lead, and found that it lay ' 18 fathom deep, faſt on the ground under the water, and 10 fathom above ' the water.'

THAT ſnow lying long, and too long on the ground, does much conduce to the fertilizing of it, is a common obſervation of our huſbandmen. And *Bartholinus* in his treatiſe of the *uſe of Snow*, brings ſeveral paſſages out of authors to make it good: to which I ſhall add the teſtimony of our learned Engliſh ambaſſador, Dr. *Fletcher*, who ſpeaking of the fruitfulneſs of the ſoil, and haſty growth of many things in the great empire of *Ruſſia*, gives this account of it.

Purchas, lib. 3. cap. 1. pag. 415.

' THIS freſh and ſpeedy growth of the ſpring there ſeemeth to proceed from the ' benefit of the ſnow, which all the winter time being ſpread over the whole country, ' as a white robe, and keeping it warm from the rigour of the froſt, in the ſpring- ' time (when the ſun waxeth warm, and diſſolveth it into water) doth ſo throughly ' drench and ſoak the ground, that it is ſomewhat of a ſlight and ſandy mold, and ' then ſhineth ſo hotly upon it again, that it draweth the herbs and plants forth in ' great plenty and variety, in a very ſhort time.'

As we made ſome trials to diſcover, whether congelation would deſtroy or conſiderably alter the odours of bodies: ſo we had the like curioſity in reference to divers other qualities, not only thoſe, that are reputed manifeſt, as colours and taſtes, the latter of which we ſometimes found to be notably changed for the worſe in fleſh congealed, but alſo thoſe, that are wont to be called occult: and among the qualities of this ſort, I had particularly a mind to try, whether the purging faculty of cathartick would be advanced or impaired, or deſtroyed by congelation; and for this purpoſe I cauſed to be expoſed thereunto divers purging liquors, ſome of a more benign, and ſome of a briſker nature, and that in differing forms, as of ſyrup, decoction, infuſion, *&c.* But for want of opportunity, to try upon the bodies of animals, what change the cold had made in the purging liquors, it had congealed, I was unable to give my ſelf an account of the ſucceſs of ſuch experiments. Only ſince, in ſome of theſe trials I had a care to make uſe of cathartick liquors prepared by fermentation (which way of preparing them is it ſelf a thing I elſewhere take notice of, as not unworthy to be proſecuted) I ſhall add on this occaſion, that fermentation is ſo noble and important a ſubject, that the influence of cold upon it may deſerve a particular inquiry. And I am invited to think, that that influence may be very conſiderable, partly by my having obſerved (upon a trial purpoſely made) both that raiſins and water, (with which I was uſed to make artificial wines) did not in many days, whilſt the weather was very froſty, ſo much as manifeſtly begin to ferment, though the water were kept fluid: and partly by my having obſerved, that beer will continue as it were new, and be kept from being, as they call it, ready to drink, much longer than one would readily ſuſpect, if very froſty weather ſupervene, before it have quite finiſhed its fermentation; inſomuch, that an experienced perſon, of whom I afterwards inquired about this matter, aſſured me, that beer not duly ripe, would not ſometimes in five or ſix weeks of very froſty weather, be brought to be as ripe as in one week of warm and friendly weather. But we have a nobler inſtance to our preſent purpoſe, if that be true, which I learned from an intelligent Frenchman, whom I conſulted about this matter. For, according to this experienced perſon, the way to keep wine in the muſt (in which ſtate, its ſweetneſs makes it deſired by many) is to take newly expreſſed juice of grapes, and having tunned it up before it begins to work, to let down the veſſels (which ought to be very carefully cloſed) to the bottom of ſome deep well or river, for ſix or eight weeks, during which time the liquor will be ſo ſettled (if I may ſo ſpeak) in the conſtitution, it has ſo long obtained, that afterwards it may be kept in almoſt the ſame ſtate, and for divers months continue a ſweet, and not yet fermented liquor; which ſome, in imitation of the French and Latins, call in one word, *Muſt*. And how, by the help of cold well applied, ſome other juices, that are wont to work early, and to be thereby ſoon ſpoiled, may be long kept from working, the reader may perchance learn in another treatiſe, to which ſuch matters more properly belong.

It is known, that the ſchools define cold by the property they aſcribe to it, of congregating both heterogeneous and homogeneous things. I thought it not amiſs to attempt the making ſome ſeparations in bodies by the force of cold. For if that hold true in this climate, which has been obſerved by travellers and navigators in northern regions, that men may obtain from beer and wine a very ſtrong ſpirit, and a phlegm by congelation; it ſeems probable, that in divers other liquors the wateriſh part will begin to freeze before the more ſpirituous and ſaline: and if ſo, we may be aſſiſted to make divers ſeparations, as well by cold, as by heat, and dephlegm, if I may ſo ſpeak, ſome liquors, as well by congelation as by diſtillation. But I doubt, whether the ordinary froſts of this country can produce a degree of cold great enough to make ſuch diviſions and ſeparations in bodies, as have been obſerved in the more northern climates. For though having purpoſely hung out a glaſs-bottle with a quart of beer in it, in an extraordinarily ſharp night, I found the next morning, that much the greateſt part of the beer being turned into ice, there remained ſomewhat nearer the middle, but nearer the bottom, an uncongealed liquor, which to me and others ſeemed ſtronger than the beer, and was at leaſt manifeſtly ſtronger than the thawed ice, which made but a ſpiritleſs, and, as it were, but a dead drink; yet in ſome other trials, my ſucceſs was not ſo conſiderable as ſome would have expected. For having put one part of high rectified ſpirit of wine to about five or ſix parts, if I miſremember not, of common water, and having put them into a round glaſs, and placed that in beaten ice and ſalt, though the mixture were in great part turned into ice; yet I could not perceive, that even two liquors ſo ſlightly mingled were any thing accurately ſevered from one another, although once, to enable my ſelf the better to judge of it, the ſpirit of wine I employed was beforehand deeply tincted with cochineal; and therefore I the leſs wonder, that in claret wine I could not make any exact ſeparation of the red and the colourleſs parts: I thought it not amiſs to try, how far in ſome other liquors this way of ſeparating the wateriſh, and more eaſily congealable part from the reſt, would or would not ſucceed. And I remember, that a large glaſs veſſel, wherein ſpirit of vinegar was expoſed to the cold, a conſiderable part was turned into ice, whoſe ſwimming argued it to be lighter than the reſt of the liquor. But though I put ſome of this ice in a glaſs by it ſelf, to examine by its weight and taſte, when thawed, how much it differed from the uncongealed part of the ſpirit, my hopes were diſappointed by a misfortune, which was not repaired by my expoſing afterwards a ſmaller quantity of ſpirit of vinegar to the nocturnal air; for that proved ſo cold, that the whole was turned into ice: wherefore I muſt reſerve for another opportunity the proſecuting that experiment, as alſo the trying, whether a ſeparation of the ſerous or the oleaginous parts of milk may be effected. For though once the froſt ſeemed to have promoted a ſeparation of cream, notwithſtanding that the heat alſo may do it; and though another time there ſeemed to be another kind of divulſion of parts made by congelation; yet for want of leiſure to proſecute ſuch trials, they proved not ſatisfactory, no more than did ſome attempts of the like nature, that I made upon blood by freezing it. But notwithſtanding theſe diſcouragements, I reſolved to try, what I could do upon brine. For calling to mind the relations mentioned in the XVth title, and elſewhere, which ſeem to argue, that in ſome caſes the ice of the ſea-water may, being thawed, yield freſh water; and being the more inclined to think it worth trial, by a phyſician, I ſince happened to diſcourſe with about this matter, who affirmed to me, that ſailing along the coaſt of *Germany*, he had taken out of the ſea ice, that being thawed, he found to afford good freſh water; I began to conſider, whether we might not, by cold, free ſalt-water at ſome ſeaſons of the year from a great deal of the phlegm, which it is wont to coſt much to free it from by fire, and other means. For a little help towards the diminution of the freſh water is looked upon as ſo uſeful an experiment, by many, that boil ſalt out of the ſalt ſprings, that in ſome countries, that are thought the ſkilfulleſt in that trade, they make their ſalt-water fall upon great bundles of ſmall bruſh-wood, that being thereby divided, and reduced to a far greater ſuperficies, there may, in falling through, ſome of the purely aqueous parts exhale away: wherefore, diſſolving one part of common ſalt in forty-four times its weight of common water, that it might be reduced, either exactly, or near, to the degree of ſaltneſs, that has been by ſeveral writers obſerved in the water of our neighbouring ſeas, and having likewiſe cauſed another and much ſtronger brine to be made, by putting into the water a far greater proportion of ſalt, (for ſo there is in many of our ſalt ſprings) we expoſed theſe ſeveral ſolutions to the congealing cold of the air in froſty weather, where the laſt mentioned ſolution being too ſtrongly impregnated with the ſalt, continued ſome days and nights altogether uncongealed, but that weaker ſolution, which emulated ſea-water, being expoſed in a ſhallow and wide-mouthed veſſel, (that ſhape being judged the moſt proper we could procure for our deſign) the large ſuperficies, that was expoſed to the air, did, as we expected, afford us a cake of ice; which being taken off, and the reſt of the liquor expoſed again to the air in the ſame veſſel, we obtained a ſecond cake of ice: and taking the remaining, which ſeemed to be indiſpoſed enough to congelation, we found, that by comparing it with that, which was afforded us by the firſt cake of ice permitted to thaw, there appeared a very manifeſt difference betwixt the water, whereinto the ice was reſolved, ſcarce taſting ſo much as brackiſh; whereas the liquor, that had continued uncongealed, was conſiderably ſalt in taſte. And if I had had the conveniency of examining myſelf theſe two liquors hydroſtatically, as I was fain to have them examined by another, I doubt not but by their weight I ſhould have diſcovered preciſely enough the difference between them (which the perſon I employed found to be conſiderable) and conſequently ſhould have been aſſiſted to make an eſtimate of the advantage, that might be afforded by the operation of the cold towards freezing of the brine from its ſuperfluous water. But though I had not a quantity of ice great enough to ſatisfy me, whether that little brackiſhneſs of taſte, I have mentioned, proceeded from ſome ſaline corpuſcles, that concurred to the conſtituting of the ice itſelf, or did only adhere to the lower part of it, among other particles of the liquor, that remained uncongealed; yet perhaps it were not amiſs to try, whether in very large, though not deep veſſels, this experiment, eſpecially promoted by ſome expedients, that practice may ſuggeſt, may not, in ſome ſeaſons and places, be brought to be of ſome advantage.

Whilst I was endeavouring by ſome of the above-recited experiments, to make ſome ſeparations in liquors by congelation, I thought fit to try, by the ſame means, what ſeparations I could make in ſome bodies, betwixt liquors, and thoſe more ſtable parts, among which they were engaged; hoping, upon conſiderations, which it were too long to enumerate, that, if ſuch attempts ſhould ſucceed, they might afford hints of a luciferous nature. I took then divers vegetable ſubſtances of differing kinds, as turneps, carrots, beets, apples, and tender wood, freſhly cut off from growing trees; as alſo divers animal ſubſtances, as muſculous fleſh, livers, brains, eyes, tongues, and other parts, and expoſed them to a very ſharp cold, that they might be throughly frozen. Now one of the chief things, that I propoſed to myſelf in this attempt, was, to try, how far I could by congelation make diſcovery of any thing about the texture of animals and plants, that had not been taken notice of by anatomiſts themſelves, and would ſcarce otherwiſe be rendered viſible. And I eaſily found, that I had not groundleſly imagined, that in divers ſucculent bodies, both vegetable and animal, the ſap or the juice, that was ſo diſperſed among the other parts, and divided into ſuch minute portions, as not to be manifeſtly enough diſcriminated, might, by congelation, be both diſcerned and ſeparated from the reſt. For in divers plants, I found the alimental juice to be congealed into vaſt multitudes of diſtinct corpuſcles of ice; ſome of which, when the bodies were tranſverſly cut with a ſharp knife, and left awhile in the air, might be wiped or ſcraped off from the ſuperficies of the body, upon which it would after a while appear in the form of an effloreſcence, almoſt like meal: but in others I took a better and quicker courſe, for by warily compreſſing the frozen bodies, I could preſently make the icy corpuſcles ſtart in vaſt numbers out of their little holes; and though ſome of theſe were ſo minute as to invite me to uſe a microſcope, that magnified a little, (not having then any of my beſt at hand) yet in ſome bodies, and eſpecially in carrots and beets, the icy corpuſcles were big enough to be diſtinctly or apart conſpicuous, inſomuch that I was not miſtaken in hoping, that the figures, as well as ſizes, (for as to the colour, it was ſcarce diſcernible in the ice, produced in ſo deeply crimſon a root, as the beet itſelf) of theſe little pieces of ice, might be gueſt at by the bigneſs and ſhape of the pores, that were left in the more ſtable part, or (if I may ſo call it) the parenchyma of the root; though in making an eſtimate of theſe cavities, as well as in diſcovering the order, wherein they are ranged, I found it uſeful to cut the frozen roots, ſometimes according to their length, and ſometimes quite croſs. For by that means there would appear in carrots, for example, of the larger ſort, a great diſparity in the order of the pores; which, when the root was divided by a plain parallel to the baſis, appeared placed in lines almoſt ſtrait, tending, almoſt like ſpokes of a wheel, from the middle to the circumference. But if the carrot were ſlit from one end towards the other, the icy corpuſcles and pores would ſeemed ranged in an order, that would appear very differing, but which I have not now the leiſure to deſcribe; no more than what I obſerved with a microſcope, Of the Uſefulneſs of Experimental Philoſophy.

about the ice and pores of apples, the tongues of animals, chips of green and ſappy wood, *&c.* expoſed to congelation. Only this I ſhall not pretermit, that as I many years ſince made (and, as I now find, too freely communicated) an experiment (mentioned long after in other papers) of freezing the eyes of oxen, and other animals, whereby the ſoft and the fluid humours of that admirable organ may be ſo hardened, as to become tractable, even to unſkilful diſſectors; ſo I did, on this occaſion, apply that experiment to the brains of animals, which, though too ſoft to be eaſily diſſected, eſpecially by thoſe who are not dexterous, may, by congelation, be made very manageable by them: and beſides, that in diſſecting the hardened brain, it ſometimes ſeemed, that the knife did cut through multitudes of icy corpuſcles (as when one cuts a frozen apple) the ſubſtance of the brain ſeemed alſo to the eye to be ſtuffed with them, and the ventricles of it did at leaſt conſpicuouſly harbour pieces of ice, if it were not filled up with them. And the manifeſt difference of texture, that there is between the white and yolk of a throughly frozen egg, and alſo betwixt the cryſtalline and the aqueous, and the vitreous humours of the eye, wherein by congelation the cryſtalline alone loſes its tranſparency, but acquires no conſpicuous ice, whilſt the others are full of ice, and that diaphanous; theſe and ſuch like diſparities, I ſay, may invite one to hope, that ſome things may, by congealing of bodies, be diſcovered about their texture, that may afford ſagacious anatomiſts improvable hints.

I KNOW not, whether it will be thought worth while to take notice, that neither an eye, nor a liver, nor a lean piece of fleſh, nor a live fiſh, nor a living frog, being frozen and put into cold water, was obſerved to be upon its thawing caſed with ice, as frozen eggs and apples are wont to be; becauſe having forgot to make the experiment above once, I dare not much rely on it. But whereas we have formerly obſerved, that congelation does moſt commonly ſpoil, or at leaſt impair eggs, and apples, and fleſh, and many other bodies, I think it may not be unworthy to be conſidered, how far, and in what caſes we may give a mechanical account of this phænomenon. For though the immerſion of frozen bodies in cold water be allowed to thaw them, with leſs prejudice, than if they were thawed haſtily by the fire, or ſuffered to thaw themſelves in the air; yet there have been complaints made, that notwithſtanding this expedient ſeveral bodies have been much the worſe for having been thoroughly frozen, now ſince I have lately ſhewn, that in many ſtable bodies, the alimental juice is by congelation turned into ice, and have formerly evinced, that water and aqueous liquors are expanded by congelation, I ſee not, why we may not ſuſpect, that the innumerable icy corpuſcles, into which the alimental juice is turned by the froſt, being each of them expanded proportionably to their reſpective bigneſſes, may not only prejudice the whole, by having their own conſtitution impaired, as has been formerly obſerved in Alicant, and other vinous liquors, but may, upon their expanſion, cruſh in ſome places, and diſtend in others, the more ſtable parts, in whoſe cavities they were harboured; and thereby ſo vitiate their texture, as to impair ſome of their qualities, and diſpoſe the compoſitum to corruption. How much contuſion may prejudice tender bodies, and accelerate putrefaction, is evident in many fruits, eſpecially the more tender ones, which having been bruiſed, quickly begin to rot in thoſe parts, that have been injured. And it is agreeable to what has been formerly ſhewn, to conceive, that in congelation there ſeems to happen an almoſt innumerable multitude of little contuſions, made by the fluid parts hardened and expanded by froſt, of the formerly more ſtable parts every where intercepted between them: and though theſe icy corpuſcles be but ſmall, yet the ſides of that ſtable matter, that ſeparates them, and which they endeavour to ſtretch or cruſh, are oftentimes proportionably thin.

And we have formerly noted, that, beſides that eggs will be burſt by having their alimental juice frozen, both ſhingles and ſtones themſelves may have their texture ſpoiled by the congelation of the mineral ſap, that is in exceeding minute and inſenſible particles diſperſed through thoſe bodies: and the violation of the texture of plants, herbs, and animals, by the expanſion of the aqueous and juicy particles, which, though they be not congregated, do abound in them, will be the leſs wondered at, if it be remembered, that our former trials manifeſt, that a few ounces of water congealed did not only burſt glaſs and pewter veſſels, but even the iron barrel of a gun.

Whilst I was upon theſe trials, I had alſo a curioſity to know, whether by freezing animals to death, I could diſcover any ſuch change in the qualities or ſtructure of their parts, as might help us to diſcover, by what means it is, that exceſſive colds kill men in northern countries, ſince ſuch a diſcovery might probably be of good uſe to the people that live in thoſe gelid regions: but having taken a young rabbit, as the tendereſt and fitteſt beaſt, I could then procure for ſuch a trial, and having expoſed him all night to an extraordinarily bitter froſt, without finding him otherwiſe miſchiefed by it, than that one of his legs was ſwelled and grown ſtiff, I was more inclined to reſign over to others, than to repeat myſelf what ſeemed to be an ill-natured experiment, though perhaps it may have much leſs of cruelty than one would think, ſince ſome of our former obſervations have made it probable, that oftentimes the extinction of life by cold is a more indolent kind of death than almoſt any other. But in a rabbit purpoſely ſtrangled, and preſently expoſed intire to a bitter cold, we found ice produced in ſuch parts, as would have made us proſecute the trial, had the want of ſuch animals and of leiſure not hindered us.

It is affirmed by divers eminent writers, and thoſe modern ones too, that water impregnated with the ſaline parts of the plants, and afterwards frozen, will exhibit in the ice, the ſhape of the ſame plant; and the learned, but I fear too credulous, *Gaffarel* tells us, that this is no rarity, being daily ſhewn by one *Monſieur de la Clave*. But to what we have already publiſhed in another treatiſe *, to ſhew that this experiment, as it is wont to be delivered, is either untrue, or very contingent; we ſhall need but to add, that, ſince the experiments there mentioned, we did again lately try, what could be done with decoctions, that were richly imbued, and highly tinged with the ſpirituous parts of the vegetables; but this ice was by no means ſo figured as the patrons of the tradition promiſe: and I remember, that having alſo made, for curioſity ſake, a lixivium with ſixteen parts of water, and but one of ſalt of potaſhes, that the mixture might be ſure to freeze; and having expoſed the liquor in a thin glaſs phial to an exceeding cold air, we found the copious ice produced to lie on the top in little ſticks, not unlike thoſe priſmatical bodies, wherein ſalt-petre is wont to roch; and thoſe parts of this ice, that were beneath the water, were ſhot in thin parallel plates, exceeding numerous, but (as one of our notes expreſly informs us) no way in the ſhape of trees, by whoſe incineration nevertheleſs Polonian pot-aſhes (as eye-witneſſes, that deal in them, inform me) are made.

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* *Rem vero adeo obſcuram exemplis ſimilibus illuſtrabo braſſicæ: aqua congelata braſſicam repreſentat, ſpiritibus vegetalibus à frigore cencentratis.* Tho. Bartholinus *de uſu nivis*, pag. 17.

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Long after the making of the newly recited experiment, I chanced to find, that the learned *Bartholinus* in the treatiſe, we have often had occaſion to take notice of, ſays, '* That the water, wherein cabbage has been decocted, will, when frozen,

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* *Rem vero adeo obſcuram exemplis ſimilibus illuſtrabo braſſicæ: aqua congelata braſſicam repreſentat, ſpiritibus vegetalibus à frigore concentratis.* Tho. Bartholinus *de uſu nivis*, pag. 17.

‘ repreſent a cabbage; the vegetable ſpirits being, as he ſuppoſes, concentrated by ‘ the cold.’ How well this experiment may ſucceed, when made in a cold country like his, I do not know; but not having my ſelf, when I firſt took notice of it, the opportunity to try it ſatisfactorily by help of a froſty night, all I could do, was, to take a good decoction of cabbage, and filtrate it through cap paper, that it might be, though yellow, yet clear; and then by the circumpoſition of our frigorifick mixture, we froze this liquor in a thin glaſs phial, but the ice did not, either to me or others, appear to have any thing in it like a cabbage, or remarkably differing from other ice. And being afterwards befriended with two or three froſty nights, we expoſed a decoction of cabbage, to be congealed by the nocturnal air alone, without the help of art; but neither this way did the experiment ſucceed well. And tho' once a few ounces of the decoction being lightly frozen in a phial, there appeared in the thin ice, that adhered to the inſide of the glaſs, a figure not ſo very unlike that of a cabbage-leaf, but that ſome ſuch accident may have invited our learned author to think, that the repreſentations of cabbages would conſtantly appear in their frozen decoctions; yet I was inclined to think this figuration rather caſual, by the curioſity I have had to freeze the decoctions of ſeveral herbs, ſome of them ſpirituous enough, as roſemary, and penny-royal, without being able to find in the ice, I obtained from them, any conviction of the truth of the tradition we are examining. And I have lately had more than once, by freezing fair water alone, after a certain manner, ice, that ſeemed much more to exhibit the ſhapes of vegetables, than any decoctions of them, that I have made. And particularly I found more than once, that by putting hot water into a ſomewhat ſlender cylinder of glaſs, and agitating it in a frigorifick mixture, conſiſting of beaten ice, ſalt, and water, ſo that it was very ſpeedily frozen thereby, it was congealed into an ice much more regularly and prettily figured, than I have ſeen it in divers of the waters impregnated with the fixed ſalts of plants, though of theſe we are told ſuch wonders.

SUCH particulars as theſe, joined with what I have elſewhere obſerved to the ſame purpoſe, make me, I confeſs, ſomewhat ſurprized to meet in *Berigardus*'s forecited diſcourſe upon *Ariſtotle*'s meteors ſuch a paſſage as this; *Paucis notum eſt, cur intra glaciem cernuntur interdum multiformes ſtirpium imagines in ampullis vitreis, aquæ ſuperficie tenus congelatæ plenis. Hoc autem fit injecto in phialas ſale diverſarum ſtirpium, nam ubi erit ſal alicujus plantæ & artemiſiæ, in ſuo lixivio glacies adhærens vitro refert ejus folia lacinioſa: ſimiliter in alia phiala videbuntur folia plantæ, cujus ſal in ſuam aquam fuerit injectus. Et nè quis hoc fortuito cadere putet, in aquâ ſæpius ſolutâ & congelatâ eædem imagines ſemper occurrent, ut vel ex eo dixeris multiplicem ſpiritum ſalis in principiis naturalibus eſſe ponendum.* Thus far this author, who would have done well, if he had been ſo much more lucky than other men, as to have performed theſe things, to aſſure expreſly of his having done ſo thoſe many ingenious men, that much diſtruſt the relations of thoſe chymiſts, that are not of the beſt ſort: and it is of ſuch ſuſpicious authors, that I here declare once for all, that I would have the reader underſtand all the paſſages of this book, wherein I may ſeem to ſay any thing (for avoiding of tedioufneſs) indefinitely to the diſparagement of chymiſts. And in caſe he had not tried them, he ſhould, in gratitude to the authors of them, have told us, he had, what he delivers of them, but from others, and not have authorized the untried reports of writers, not always too veracious, by his building theories upon them. And as for what he immediately ſubjoins, and ſeems to rely on, out of *Quercetan*, (and other ſpagyrical writers, who poſſibly had it themſelves from him) about the ſeminal virtues ſurviving in the aſhes of burnt plants; though I will not here examine, or abſolutely reject the opinion, becauſe the diſcuſſion of it belongs to another place; yet as to the experiment, whereon *Berigardus* and others rely, namely, that the lixiviums made of the aſhes of plants, will exhibit, being congealed, the figures of the priſtine vegetables; beſides that a general concluſion, as to other plants, ſeems to be inferred from what happened in nettles only, I much doubt, whether that famous experiment it ſelf of the frozen lixivium of nettles were more than caſual, if it were not alſo aſſiſted by an indulgent fancy. For having, after divers experiments made with other fixed ſalts, purpoſely repaired, for greater ſecurity, to the notedeſt chymiſt in *England*, to obtain from him ſome fixed ſalts, very faithfully prepared, and intimating withal, that it was to try ſuch an experiment (which he was a favourer of) I did, by mingling theſe ſalts each in a diſtinct phial, ſometimes with one, and ſometimes with another proportion of water, and afterwards expoſing them to the cold air, obtain indeed divers portions of ice, but without any ſuch figurations, as the learned *Berigardus* would have expected; though ſome of theſe trials were made more than once, as well with the lixivium of nettles, as with the lees of other plants. So that I doubt this author is more ſcrupulous in admitting ſome important truths, in which the beſt philoſophers, as well heathen as Chriſtian, agree, than in examining the uncertain traditions of the chymiſts, whoſe unſatisfactory way of ſetting down matters of fact I am induced to take notice of his imitating, by finding, that in the very ſame page (that I have newly cited) he relates another chymical experiment in theſe terms: *Velim porro oſtendere mirabili experientiâ quàm ſint penetrabiles aliqui ſpiritus corporei: exarentur in charta literæ, aceto albo, quarum nullum veſtigium deprehendatur, claudaturque primis foliis craſſiſſimi alicujus libri. Paretur alia charta, quæ inficiatur aqua illa fœtida, ubi dilutum fuerit auripigmentum, & exſiccata claudatur poſtremis foliis ejuſdem libri leviter compreſſi, ſtatim videbis in priori charta literas conſpicuas, perinde ac ſi atramento ductæ fuiſſent.* Now, though ſomething like what is here propoſed to be done, may be performed, and other phænomena of the experiment, ſuch as he ſeems not to have been acquainted with, may be alſo exhibited, after the manner I have * elſewhere particularly ſet down; yet he muſt have good luck, that performs it only by the directions here given by our author, who by omitting one of the chief ingredients, and ſome requiſite circumſtances, appears indeed manifeſtly enough to have heard of ſuch an experiment, but without ſeeming to have ſufficiently known, what he pretends to teach, (at leaſt as far as his bringing this experiment as a proof, and the obſcure ſtyle, he is wont to employ in the little I have yet read of his book, permits me to judge.)

* In the unpubliſhed ſection of the Uſefulneſs of experimental philoſophy.

Of the Unſucceſsfulneſs of experiments.

BUT to return to the figurations of ice, notwithſtanding ſuch unſucceſsful trials about them, as I have been mentioning, I will not deny it to be poſſible, that a prepoſſeſſed and favourable ſpectator may think himſelf to have diſcerned in the ice, the figures he looked for there. For ſince the writing of the eſſay not long ſince quoted, we have found, that ſeveral bodies, and even ſea-ſalt, and alum, to whom nature has given their own determinate figures, have, when diſſolved in water, concurred with it to exhibit an ice very oddly, as well as prettily, figured, (nor will I preſume to determine the utmoſt, that a lucky obſerver may ſometimes meet with in this kind) but to name at preſent no other arguments, the figures this way produced were too various and extravagant, not to be referred to chance, and not to afford inſtances, how much that can perform in the exhibiting of ſuch apparitions.

ON which occaſion I ſhall add, that I remember, I once ſhewed at the Royal Society a glaſs head, whoſe inſide was lined with a certain ſubſtance, that paſſed for ſaline, faſhioned into the figures of trees, as curious, as if they had been drawn by a limner: and yet as I produced theſe figures, only by rectifying common oil of turpentine, from ſea-ſalt (which ſalt I elſewhere ſhew not to be neceſſary) in a certain degree of heat; ſo by varying that degree of heat, I could make the aſcending ſteams ſettle in other figures. And I can eaſily produce very pretty ſhapes of trees by diſtillation of that, which belongs not to the vegetable, but the animal kingdom. And to theſe I could add divers other inſtances of the like tendency, to make it ſtill the more probable, that though oftentimes one may happen to find pretty ideas, or apparitions in ice; yet the like, or as fine, may be produced by chance. And I have ſometimes obtained by freezing infuſions, decoctions, ſpirits, ſolutions, and other liquors, as vinegar (and particularly) milk, and even common water, figures, that were ſo pretty, but withal ſo unconſtantly produced, and ſo eaſily variable by circumſtances, that as it would fill a book particularly to deſcribe them (which for that reaſon I hope to be excuſed for declining) ſo they would much delude him, that ſhould ſuſpect to find them every time the ſame, that he had found them once.

AND to intimate that by the by, to make ſeveral trials in a ſhort time, and thereby produce variety of figures, it is not an ill expedient to expoſe the liquor one would have congealed, in very ſhallow veſſels; or, if it be put into other veſſels, to leave it but of very little depth. And if the veſſel it ſelf be highly refrigerated, either by the cold air, or by having ſalt and ice applied to the outſide of it, the congelation may ſucceed much the more nimbly; ſo that within a ſhort while the ſame liquor, being divers times thawed and frozen again, may poſſibly exhibit variety of figures. And the production of ice may be alſo much accelerated, by dipping into the liquor, one would have congealed, the convex ſurface of ſome glaſs or other ſmooth body, that will not imbibe water; for thereby the depth of the liquor will be exceedingly extenuated, and how much ſuch a thinneſs or want of depth, may diſpoſe a liquor to be ſpeedily penetrated and congealed by the cold, may be gueſſed, by what is above delivered in the ſection out of *Olearius*, of the way of multiplying ice in *Perſia*, by making water thinly diffuſe it ſelf over a plate of ice, or ſome other aptly figured, and very cold body: in confirmation whereof, I will add on this occaſion, that I have ſeen a pair of ſtairs, on which, though they were ſituated near to three chimneys, commonly furniſhed with fire, almoſt all the day long, the water, that was employed to waſh them, being thinly ſpread with a mop, would preſently congeal (though they aſſured me it was hot, when it was begun to be laid on) and cover the ſtairs with gloſſy films of ice. And I have likewiſe obſerved in a very ſharp night, that the water, which dropped down from the noſe of a pump, was ſo well congealed, as it was ſliding away, that the ice thus arreſted in its paſſage (in which it will eaſily be granted that it ſpreads it ſelf very thinly) had raiſed a kind of icy pyramid of a conſiderable bigneſs and height.

I FORGOT to mention in due places (and therefore think fit to take notice of it here) that when I was conſidering of the ways, whereby it might be manifeſted to thoſe, that want nice ſcales, or diſtruſt their ſkill to uſe them, whence that ice comes, that appears on the outſide of frozen eggs put to thaw in cold water, I found it ſomewhat difficult to pitch upon ſuch liquor as I deſired. For if common water be the liquor employed, it may be ſaid, that it affords the matter, whereof the ice in queſtion is made: and if I employed liquors, that were ſpirituous or ſaline, it might be pretended, that the froſt (as they ſpeak) did indeed come out of the frozen egg, though the ſhell did not appear caſed with ice, becauſe as faſt as the froſt came to the outſide of the egg, it was reſolved by the ſpirituous or ſaline corpuſcles of the liquor: wherefore as an expedient, I reſolved to make uſe of oil of turpentine, as a liquor, which

I had found uncongealable by the greateſt cold I had obſerved in our climate, and which yet (as may appear by the third paragraph of the XVIth title) was more indiſpoſed, than common water itſelf, to thaw any icy efflorеſcence, that might be emitted by the egg. But the experiment was tried, without uniformity in the ſucceſſes. For the firſt time I put a frozen egg into oil of turpentine, I did not obſerve, that any ice was produced on the outſide: neither was the event differing, when another time I put two frozen eggs together into a ſmall veſſel full of that oil, though to refrigerate the liquor, the veſſel was for a while placed upon a mixture of ſalt and ice, though alſo the egg-ſhells at their gaping cracks (produced by congelation) diſcovered, that the contained liquor was well frozen. I intended to proſecute the experiment another time (wanting ice to do it then) becauſe that once, when during the trial I was hindered from watching it, one of my domeſticks, whom I ordered to look after it, aſſured me, that the egg, that was put to thaw in the oil of turpentine, had there obtained ice on the outſide of it; which I ſhould readily have believed, upon the ſcore of a like obſervation, I had made my ſelf, in two eggs that were frozen to the bottom of the veſſel, wherein they had been put to thaw, were it not, that one or both of them had been, by a miſtake, dipt in water, before they were put into the above mentioned oil.

Some readers may have expected to find, among the examples recited of the influence of cold upon the air, that ſtrange ſtory, which is related by the learned *Joſephus Acoſta*, of the mountains of *Pariacaca*, (which he ſeveral times traverſed:*) but beſides that I have delivered a great part of it already in another treatiſe, I was loth to ſay more, till I had leiſure (which I have not now) to diſcuſs the ſcruples, that I have not ſo much about the matter of fact, as about the cauſe, which perhaps may be ſomething beſides cold. But ſince I have mentioned this XVIIIth ſection, I will here take notice of what I then intended, but forgot to ſet down; namely, that to the inſtances alledged to ſhew the coldneſs of regions not to be always proportionate to their greater and leſs vicinity to the pole, we may add a memorable one afforded us by a country ſo well known to many of us, as *New England*; where, though the winters are ſo long and bitter, as we have formerly related out of Mr. *Wood*'s proſpect of that country, (which has been confirmed to me by an American phyſician, that lived there;) yet that region, which is ſo much colder than ours, is in many places no leſs than ten or eleven degrees remoter from the pole.

I shall add to the ſame XVIIIth ſection, that as to the experiment I there mentioned concerning winds, and which I aſſociate with the teſtimony of the newly named Mr. *Wood*; I find, that the ſeaſon of the year, and ſome other circumſtances, may vary it more than one would eaſily have ſuſpected. For though I faithfully recited the phænomena, as I then (and that ſometimes with witneſs) took notice of them, yet ſome months after, and in other weather, having occaſion to repeat the former part of that experiment, I was ſomewhat ſurprized at the ſucceſs. For coming to blow upon the ball of a ſealed weather glaſs, which though in its kind very tender, might be probably preſumed to be leſs ſo, than a thermoſcope made with a pendulous drop of water (ſuch as that, mentioned in the forecited paragraph) I found, that if I continued to blow any thing long and briſkly, the highly rectified ſpirit of wine (which circumſtance I therefore name, becauſe poſſibly the nature of that may ſomewhat alter the caſe) would ſometimes manifeſtly enough ſubſide. And in that paragraph of the 18th title, where I recited the experiment of the infrigidating winds, I ſhould more expreſly have taken notice of this circumſtance, that to ſatisfy my ſelf, that it was not the bare wind, as ſuch, whoſe operation upon the air included in the ball of a weather-glaſs, made the liquor to aſcend, we put a mark upon the height it ſtood at, when we had a pretty while blown upon it; and then, without removing the bellows, put ice and ſalt about the iron pipe of it. By which mixture the air that was afterwards blown through that pipe, was ſo cooled in its paſſage, as to make the liquor very manifeſtly to aſcend, even in a weather-glaſs, where I did employ (as I have elſewhere declared, that I often do) quickſilver inſtead of water, or ſpirit of wine. And leſt the vicinity of the frigorifick mixture ſhould be ſuſpected to have cauſed this contraction of the included air, we did ſometimes purpoſely intermit the moving of the bellows, without removing the weather-glaſs; and though, notwithſtanding that vicinity, the liquor would begin a little to ſubſide; yet when ever the cold ſpirits, or the corpuſcles of highly refrigerated air, were, by the playing of the bellows anew, approached to, or rather brought to touch in ſwarms the globular part of the inſtrument, the mercury would manifeſtly aſcend. And ſince we are ſpeaking of weather-glaſſes, I ſhall on this occaſion ſubjoin, that certain circumſtances may alſo vary the ſucceſs of another experiment (ſomewhat of kin to that lately repeated, about the pendulous drop) which is briefly mentioned not far from the beginning of the firſt preliminary diſcourſe. For though the common thermometers, that are here wont to be ſold in ſhops, have uſually the pipe of the bolt-head very large in proportion to the ball, and therefore are in that place ſaid to be weather-glaſſes not nice; and though on ſuch inſtruments in certain temperatures of the air (intimated by the word *ſometimes*, employed in that paſſage) the air blown out of a pair of bellows againſt ſome part of the included air, would not, eſpecially at the beginning, make the air ſenſibly contract itſelf, and the liquor aſcend; though at the very firſt and ſecond blaſt, the coldneſs of this artificial wind might be very ſenſible to the touch (which was the thing intended to be taught in that paſſage) yet having the curioſity with other bellows, at another ſeaſon of the year, to blow long upon the ball of a not common but nice weather-glaſs of my own making, furniſhed with a pipe, that was very ſlender, I divers times (but not always) found the tincted liquor manifeſtly enough to aſcend, as if the wind, conſiſting of a more compreſſed air, did, by containing a greater number of cold particles in the ſame room, more affect the internal air, than the contact of the calm and lax outward air did before; which diſparity of events has given me the deſign of making further trials with differing thermoſcopes, at other ſeaſons of the year, to ſee if I can bring the matter to ſome certainty, by diſcovering the cauſe of this contingency, in which I afterwards ſuſpected, that ſome light degree of warmth or coolneſs in the bellows themſelves, which, as being unmanifeſt to the ſenſe, ſcaped unheeded, might have an intereſt. When I was about ſome of the former experiments, I would willingly have had an opportunity of trying, with a good ſealed weather-glaſs, what difference there would be, betwixt the cold of the nocturnal air in a froſty night, in places, where the air was kept calm, by being ſheltered from the wind, not by inhabited buildings, but by ſome wall, or other body, whence any warm effluviums were leaſt to be expected; and betwixt the cold of the ſame air, in places, where cold winds, eſpecially northerly or eaſterly, did freely and ſtrongly blow. But my occaſions then confining me to a town, I had not conveniency to make any ſecure obſervations of that nature; and even in a more commodious place, unleſs it were determined, whether there be corpuſcles properly and conſtantly frigorifick, upon whoſe account ſome winds are ſo much colder than others, there may ariſe more ſcruples about this matter, than I muſt now ſtay to diſcuſs.

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* Where a wonderfully piercing, though not ſenſibly violent cold, does ſometimes ſuddenly kill men, and yet preſerve their bodies untainted whole years together.

There is one thing more, that, it may be, is not impertinent to mention, before I take leave of the XVIIIth title: for in confirmation of what is there delivered, concerning the viciſſitudes of theſe troubleſome degrees of cold and heat, within the compaſs of the ſame natural day, complained of by the patriarch *Jacob*, and by *Olearius*, I ſhall add, that having ſince had opportunity to inquire about ſuch matters of a learned phyſician, lately come from the *Indies*, he aſſured me, that notwithſtanding the violent heats of the day, he uſually obſerved the nights to be ſo very cold, that he was poſitive ſome frigorifick ſteams did, in the night, aſcend out of the earth, and make it very expedient, if not neceſſary, for thoſe Engliſh, that live in the warmer parts of *America*, to imitate the natives, in keeping fires under their hammocks, or hanging-beds.

I thought it might be a luciferous experiment, in relation to an hypotheſis, that might be propoſed about cold, to try, whether, if two ſuch liquors were provided, as by being mixed together, would ſo far forth loſe their fluidity, as to obtain at leaſt the conſiſtency of an unguent, this impediment, put to the former confuſed and greater agitation of their parts, would produce any ſenſible degree of cold; this I thought fit to try, by immerſing, for a competent time, the ball of a tender ſealed weather-glaſs into each of the liquors apart, and then into the ſoft mixture, their coalition would compoſe. To produce ſuch a mixture more ways than one, it was not difficult for me, by the help of ſome experiments, I had provided to add to my *Hiſtory of Fluidity and Firmneſs*. But though a ſtrong ſolution of minium (or calcined lead) in ſpirit of vinegar, or a very ſtrong infuſion of good quick-lime in water, will either of them (and one of them I did make uſe of, though I have forgotten which) coagulate a juſt proportion of good ſallad-oil (to name no other made by expreſſion) into ſuch a conſiſtence as I have been ſpeaking of; yet for want of a ſealed thermoſcope, tender enough, I cannot now repeat the experiment, and till I do, I dare not draw any experiment from it; though, if I much miſremember not, when I ſhewed it an ingenious perſon, neither he nor I could perceive, that the liquors, by being deprived of their fluidity, had acquired any thing of coldneſs diſcoverable by the ſealed weather-glaſs.

It is much controverted among the curious, whether water be capable of compreſſion; and divers have of late inclined to the negative, upon obſerving a want of cogency in the experiments, that have been brought to evince the affirmative. What trials and obſervations we long ſince made about this matter, may be met with in ſome of our other treatiſes, wherefore I ſhall now ſubjoin, that having imagined, that cold might afford a hopefuller way, than (for aught I know) any man has uſed, of bringing this controverſy to the deciſion of an experiment, I made that attempt, that is mentioned in the XIIth title; in proſecution of which, as ſoon as I could procure ſome, though but ſome of the accommodations, which I long wanted, I made an experiment, which I ſhall ſubjoin, becauſe though it be not ſo conſiderable, as with better implements I could have made it, yet the way I choſe, has (as I partly intimated elſewhere) theſe two advantages; that the force employed to compreſs the air, is both very great, and very gradually, and ſlowly applied; and that the veſſel will not, like thoſe, that have been hitherto made uſe of, give any paſſage through its pores to water, though violently compreſſed.

We took then a round ball of glaſs, furniſhed with a moderately long pipe, and having filled it with water, till the liquor reached within ſome inches of the top, it was hermetically ſealed up, and then the water, by a mixture of beaten ice and ſalt, was made to freeze from the bottom upwards; and that without breaking the glaſs, the unfrozen water, by the expanſive endeavour of that which was freezing, might be impelled upwards; and ſo at once both compreſs the air, and be preſſed upon by it, having by this means condenſed the air, as far as we thought ſafe to do in a glaſs, that was not ſtrong, we cropt off the ſmall apex of the glaſs, and immediately the compreſſed air flew out with a great noiſe, and that part of the pipe which was unfilled with water, was filled with ſmoke, that made it look white, and great ſtore of little bubbles haſtily aſcended from the lower parts of the water, to the upper (where moſt of them quickly broke) in ſuch a way, as put me in mind of what uſually happens upon the opening of veſſels that contained bottled beer. But that, which was principally to be noted, was this, that beſides the bubbles or froth, the water itſelf (at leaſt ſuppoſing, that no little unheeded bubbles, that did not quite emerge, could ſenſibly contribute to its height) immediately aſcended in the pipe about $\frac{3}{4}$ of an inch, which (having carefully marked the firſt and ſecond ſtations, with a diamond on the outſide of the glaſs) it was eaſy for us to meaſure.

I HAVE elſewhere propoſed a ſuſpicion, that in the attempts, that had been till then made, to compreſs water, the condenſation (in caſe there were really any) might perchance proceed from the compreſſion of the aerial particles, that I have ſhewn to be wont to lie diſperſed in the pores of common water. But though the conſiderable expanſion of water, notwithſtanding the breaking of the bubbles in our preſent experiment, ſeems manifeſtly to argue, that this could be but a concurrent cauſe (if it had any ſenſible effect at all) of our phænomena, yet I dare not abſolutely rely, even upon an experiment, that ſeems ſo cogent, till I have ſatisfied myſelf, that no ſpringineſs, which I have ſometimes ſuſpected might be in the ice, had any intereſt in the produced effect; and that the great preſſure of the forcibly condenſed air, did not make the glaſs it ſelf ſtretch or yield. For if it were able to do ſo, then the parts of the violently diſtended glaſs, upon the removal of the forcible preſſure of the air (which muſt ceaſe upon the breaking of the hermetical ſeal) returning to their former ſtraitneſs below, will make the water aſcend ſomewhat higher in the pipe. But though I could not procure glaſſes, as well very thick, as conveniently ſhaped, wherewith to examine this ſuſpicion, which I likewiſe would have tried by the bulk of the glaſs in water, before and after the letting out of the compreſſed air; yet becauſe moſt readers will probably think ſo much caution more than neceſſary, I ſhall add, that if I had not wanted conveniencies, and had not had miſchances, the experiment would, in likelihood, have been advanced; eſpecially care being taken, that the air left in the pipe ſhould be well refrigerated before its being ſealed up, (as we ſometimes did by ice and ſalt, applied in a perforated box to the outſide) leſt part of its ſpring ſhould depend upon an evanid degree of heat; upon which account the pipe ought before-hand to be drawn ſo ſlender, that the glaſs may be melted together in a trice. For though for want of ſtrong glaſſes, and the beſt ſort of inſtruments to ſeal up ſuch with, the ſucceſs was not ſtill ſo conſiderable as I hoped for; yet as four or five other trials, made, as well with another liquor, as with water, did exhibit a manifeſt intumeſcence of the liquors (without computing the froth produced at the top); ſo in the experiment lately mentioned, if we had judged them ſtrong enough to endure ſuch a compreſſion of the included air, as we have often made on other occaſions, the effect would probably have been much more conſiderable. For though the difference betwixt the length of the ſame water compreſſed and uncompreſſed amounted to an aqueous cylinder of $\frac{3}{8}$ of an inch in height, yet the air, that made this compreſſion of the water, was itſelf reduced but from eight inches to five; ſo that it took up almoſt half its former room, whereas we have ſometimes reduced it to an 18th or 20th part thereof. If I had been accommodated with one of my pneumatical engines, I ſhould have tried, whether water being firſt carefully freed from the latitant air in the exhauſted receiver, and then compreſſed after the manner hitherto recited, the event of the trial would have been conſiderably varied.

I MIGHT add, as other phænomena of our experiment, that when we broke off the ſealed apex of the glaſs, before the included air was much compreſſed, there neither would be any great noiſe made, nor any conſiderable froth produced, at the top of the water; and that having had the curioſity to repeat the experiment in one of the ſame glaſſes, that had been already uſed and with the ſame water, that had been already compreſſed in it, we found, that upon the breaking off the hermetical ſeal the ſecond time, the water did nevertheleſs aſcend into the pipe betwixt $\frac{1}{8}$ and $\frac{1}{4}$ part of an inch. And to theſe particulars I could both add other circumſtances, that I took notice of in the ſame experiment, and ſubjoin many other experiments and obſervations, but that I am already tired. And though I have not found cold to be a ſubject over-fruitful in experiments pleaſing and curious, yet now I am grown ſomewhat acquainted with it, I find it may ſuggeſt ſo many other new ones, that ſince the barrenneſs of my theme will not eaſily put a period to this treatiſe, it is fit that now at length I ſhould let my wearineſs and want of leiſure do it.

# AN
# EXAMEN of ANTIPERISTASIS,
# AS
# It is wont to be TAUGHT and PROVED.

THEMISTIUS, CARNEADES, ELEUTHERIUS.

### THEMISTIUS.

1. AS for *Antiperiſtaſis*, the truth of it is a thing ſo conſpicuous, and ſo generally acknowledged, that I cannot imagine what ſhould make ſome men deny it, except it be, that they find all others to confeſs it. For though in other caſes they are wont to pretend experience for their quitting the received opinions, yet here they quit experience it ſelf for ſingularity, and chuſe rather to depart from the teſtimony of their ſenſes, than not to depart from the generality of men.

2. AND to evince, that this is not ſaid *gratis*, I might obſerve to you, that there are no leſs than three grand inducements, that have led both the vulgar and philoſophers (two ſorts of men, that ſeldom agree in other things) to conſent in the acknowledgement of *Antiperiſtaſis*; authority, reaſon, and experience. But though I think fit to name them all three, yet ſince the firſt of them, by having, as I juſt now noted, invited our adverſaries to diſſent from the truth, is a ſomewhat unlikely medium to prevail on them to acknowledge it, I ſhall inſiſt only on the two latter; having once declared, that I lay aſide the firſt, not as worthleſs in it ſelf, but needleſs to my cauſe.

3. To begin then with the arguments afforded us by reaſon.

WHAT can there be more agreeable to the wiſdom and goodneſs of nature, who deſigning the preſervation of things, is wont to be careful of fitting them with requiſites for that preſervation; than to furniſh cold and heat with that ſelf-invigorating power, which each of them may put forth, when it is environed with its contrary. For the order of the univerſe requiring, that cold and heat ſhould reſide in thoſe bodies, that often happen to be mingled with one another, thoſe two noble and neceſſary qualities would be too often deſtroyed in the particular ſubjects, that harboured them, if provident nature had not ſo ordered the matter, that when a body, wherein either of them reſides, happens to be ſurrounded by other bodies, wherein the contrary quality is predominant, the beſieged quality, by retiring to the innermoſt parts of that, which it poſſeſſes, and thereby recollecting its forces, and as it were animating it ſelf to a vigorous defence, is intended or increaſed in its degree, and ſo becomes able to reſiſt an adverſary, that would otherwiſe eaſily deſtroy it.

4. To illuſtrate as well as ſupply this argument drawn from reaſon, we ſhall need but to ſubjoin the other afforded us by experience, which does almoſt every day give us not only opportunity to obſerve, but cauſe to admire the effects of this ſelf-invigorating power, which, when occaſionally exerted, we call Antiperiſtaſis: and theſe phænomena ought the more to be acquieſced in, becauſe they may ſafely be looked upon as genuine declarations, which nature makes of her own accord, and not as confeſſions extorted from her by artificial and compulſory experiments, when being tortured by inſtruments and engines, as upon ſo many racks, ſhe is forced to ſeem to confeſs whatever the tormentors pleaſe.

5. To proceed then to the ſpontaneous phænomena of nature I was recommending, we ſee, that whereas in ſummer the loweſt and higheſt regions of the air are made almoſt unſufferable to us by their heat, the cold expelled from the earth and water by the ſun's ſcorching beams retires to the middle region of the air, and there defends it ſelf againſt the heat of the other two; though in the one, that quality be aſſiſted by the almoſt perpendicular reflection of the ſun-beams, and in the other it be rendered very conſiderable by the vaſtneſs of the upper region of the air, and its vicinity to the element of fire.

AND as the cold maintains itſelf in the middle region, by virtue of the intenſeneſs, which it acquires upon the account of Antiperiſtaſis; ſo the lightening, that flaſhes out of the clouds, is but a fire produced in that middle region, by the hot exhalations penned up, and intended in point of heat by the ambient cold, to a degree, that amounts to aſcenſion.

6. BUT though theſe be unqueſtionably the effects of that exceſſive coldneſs; yet we need not go ſo far as the tops of mountains to fetch proofs of our doctrine, ſince we may find them at the bottom of our wells. For though *Carneades* perhaps will not, yet the earth as well as the air doth readily acknowledge the power of Antiperiſtaſis. And if the reaſon above alledged did not evince it, our very ſenſes would. For as in ſummer, when the air about us is ſultry hot, we find, to our great refreſhment, that the air in cellars and vaults, to which the cold then retreats, is eminent for the oppoſite quality; ſo in winter, when the outward air freezes the very lakes and rivers, where their ſurfaces are expoſed to it, the internal air in vaults and cellars in winter, which becomes the ſanctuary of heat, as in ſummer it was of cold, is able not only to keep our bodies from freezing, but to put them into ſweats. And not only wells and ſprings, upon the account of their reſting in, or coming out of the deepeſt parts of the earth, continue fluid, whilſt all the waters, that are contiguous to the air, are by the exceſſive cold hardened into ice; but the water freſhly drawn from ſuch wells feels warm, or at leaſt tepid to a man's hand put into it. And as if nature

deſigned men ſhould not be able to contradict the doctrine of Antiperiſtaſis, without contradicting more than one of their own ſenſes, ſhe has taken care, that oftentimes the water, that is freſhly drawn out of the deeper ſorts of wells and ſprings, ſhould manifeſtly, as I have ſeen it, ſmoke, as if it had been but lately taken off the fire. And this may be ſaid, without a metaphor, to demonſtrate *ad oculum* the reality of Antiperiſtaſis; there being no other cauſe, to which this warmth can be attributed, than the retiring of the heat from the cold external air to the lower parts of the earth and water; ſince both theſe elements themſelves being naturally cold, and one of them in the ſupreme degree, the heat we are mentioning, is ſo far from being likely to be generated in ſo unfit a place, that, if it were not very great, it muſt be extinguiſhed there, by the coldneſs of the ſuperiour air, and that of the inferiour parts of the earth.

ELEUTHERIUS. 7. That *Carneades* may have but one trouble, to anſwer the allegations to be made in favour of Antiperiſtaſis, I hope he will give me leave, (according to my cuſtom of ſiding with either party, as occaſion invites me) to add to the familiar obſervations mentioned by *Themiſtius* ſome others, that are leſs obvious. For I frankly confeſs to you, that when I conſider, what intereſt the unheeded diſpoſitions of our own bodies may have in the eſtimates we make of the degrees of cold and heat, in other bodies; I ſhould not lay much weight upon the phænomena, that are wont to be urged as proofs of Antiperiſtaſis, if ſome inſtances, ſomewhat leſs liable to ſuſpicion, did not countenance the doctrine they are urged for. I know, that *Carneades* being wont ſo to propoſe his opinion about Antiperiſtaſis, as only to deny, that it is clearly made out by the reaſons or experiments, that are commonly produced to evince it, it were ſomewhat improper to urge him with obſervations, that are not familiar, and wont to be imployed; but I know too, that he is not ſo rigid an adverſary, as not to allow me to mention ſome uncommon relations, that I learned from men of good credit. I ſhall tell you then, that having purpoſely inquired of ingenious men, that had been very deep under ground, ſome in coal-pits, and ſome in mines; one of them affirmed, that, at the bottom of the grove (as they call it) or pit, he found it very hot in *September*. And another, that he often found it hot enough, to be troubleſome in winter. And a third, (who is himſelf a great ſeeker for mines, and a maſter of conſiderable ones) that he found it to be hot all the year long. And to manifeſt, that ſuch obſervations will hold even in gelid regions, I ſhall repeat to you, what I remember I read in the voyage of that ingenious navigator, Captain *James*; who, giving an account of *Charleton Iſland*, which, by his relation, ſeems to be as cold as *Iceland* itſelf, ſays, (pag. 36.) *That his men found it more mortifying cold, to wade through the water in the beginning of* June, *when the ſea was full of ice, than in* December, *when it was increaſing*. And he adds, that which makes more to our preſent purpoſe, and proves the other part of the doctrine of Antiperiſtaſis; *That, from their well, out of which they had water in* December, *they had none in* July. And, to ſtrengthen the obſervation yet further, I will acquaint you with a relation to this purpoſe, not unworthy your notice: for, hearing of an ingenious phyſician, that lived ſome years in and about *Moſcow*, I applied myſelf to him, (as poſſibly you may have done; for, if I miſtake not, I have ſeen you together) to know, whether, in that frozen region, he obſerved the cellars to be hot in winter. And his anſwer to that, and ſome other queſtions of the like nature I put to him, amounted in ſhort to this; that when I inquired, whether their ſprings and wells were not all frozen in the winter, he told me, that he ſaw ſome ſprings, whoſe waters froze not at all near the ſpring-heads, but, at a good diſtance from thence, it began to be thinly caſed over with ice. He added, that his own well was about ſix fathoms deep, between the ſurface of the earth, and that of the water, and that the water in it was, as I remember, about three or four fathoms deep; and that not only this well froze not all the winter, but that the well of his neighbour, which was but one fathom deep to the ſuperficies of the water, did not freeze neither. And, to ſatisfy my curioſity about the ſteams of this water, he told me, that when a bucket of water was newly drawn, if it were agitated, it would ſmoak; but that, from the well itſelf, when the water in it was left quiet and unſtirred, he did not perceive any ſmoak to ariſe.

8. To all this, I ſhall add this further circumſtance, that, having purpoſely inquired, whether, in the winter, he found it as hot in cellars at *Moſcow*, as it is wont to be, in that ſeaſon, in our's? he anſwered me, that when the doors and windows were carefully ſhut, to hinder the immediate commerce betwixt the included and external air, he often found, if he ſtayed long in his cellar, it would not only defend him from the ſharpneſs of the Ruſſian cold, as bitter as that is wont to be in winter, but keep him warm enough, to be ready to ſweat, though he laid by his furs. So that, if we may rely upon the teſtimony of our ſenſes, we muſt neceſſarily admit cellars to be warmer in winter, than in ſummer, and conſequently allow an Antiperiſtaſis.

CARNEADES. 9. Though I were not in haſte, I ſhould not think it neceſſary to reply any thing elſe to the firſt part of what was ſaid by *Themiſtius*, than that, what he alledges of the univerſality of the opinion he maintains, may ſerve to recommend that, which he oppoſes. For the vulgar doctrine about Antiperiſtaſis being, as he urges, received and taught in all the ſchools, the innovators, he declaims againſt, muſt have learned it there, among the other Peripatetick tenents, that youth is wont to be imbued with in thoſe places; ſo that it may rather ſeem the love of truth, than of ſingularity, that engages them againſt an opinion, which before was their own, as well as that of the generality of ſcholars; and conſequently, againſt which they cannot maintain a paradox, that does not imply a retractation. But I ſhall not proſecute my anſwer to *Themiſtius*'s preamble, ſince *Eleutherius*, whom I am chiefly to ſpeak to, is too much a philoſopher, to think truth leſs herſelf, for being ſlenderly attended; or to think any men the leſs like to be her followers, becauſe they are but few. To come then directly to the controverſy itſelf, I think, I need not tell one of you, that the other miſtakes my opinion about it. For I perceive, *Eleutherius* hath not quite forgotten, that I have not been wont to deny an Antiperiſtaſis, as it may be, but only as it was wont to be, explicated. But ſince *Themiſtius* ſeems to be willing to have me his antagoniſt in this controverſy, and ſince *Eleutherius* himſelf ſeems to conſpire with him, I am content to act, for a while, the part, you gentlemen would have me take upon me, and will propoſe to you part of what I would ſay for the opinion you impute to me, in caſe I were really of it.

10. To come then to the controverſy itſelf, though *Themiſtius* has drawn his proofs for the Antiperiſtaſis of the ſchools, partly from reaſon, and partly from experience; yet the very ſame two topicks ſeem to me to afford conſiderations, that may juſtly warrant our calling it in queſtion.

11. AND firſt, if we look upon the reaſon of the thing, conſidered abſtractedly from the experiments, that are pretended to evince an Antiperiſtaſis, we cannot but think, it may be very rational, I ſay not, to doubt of it, but to reject it. For, in the firſt place, according to the courſe of nature, one contrary ought to deſtroy, not to corroborate, the other. And next, it is a maxim among the Peripateticks themſelves, that natural cauſes always act as much as they can. And certainly, in our caſe, wherein we treat not of living creatures, I cannot but think the axiom phyſically demonſtrative. For inanimate agents act not by choice, but by a neceſſary impulſe; and, not being endowed with underſtanding, and will, cannot of themſelves be able

to moderate or to ſuſpend their actions. And as for what *Themiſtius* alledges, that it was neceſſary for the preſervation of cold and heat, that they ſhould be endowed with ſuch a power of intending themſelves, I muſt freely confeſs, that though, in living creatures, and eſpecially in the bodies of the perfecter ſorts of animals, I do, in divers caſes, allow arguments drawn from final cauſes; yet where only inanimate bodies are concerned, I do not eaſily ſuffer myſelf to be prevailed upon, by ſuch arguments. Nor is there any danger, that cold and heat, whoſe cauſes are ſo radicated in nature, ſhould be loſt out of the world, in caſe each parcel of matter, that happens to be ſurrounded with bodies, wherein a contrary quality is predominant, were not endowed with an incomprehenſible faculty of ſelf-invigoration. And nature either does not need the help of this imaginary power, or oftentimes has recourſe unto it to very little purpoſe: ſince we ſee, that theſe qualities ſubſiſt in the world, and yet, *de facto*, the bottles of water, wine, and other liquors, that are carried up and down in the ſummer, are regularly warmed by the ambient air. And in *Muſcovy*, and other cold northern countries, men, and other animals, have oftentimes their vital heat deſtroyed by the cold, that ſurrounds them, being thereby actually frozen to death. And I ſomewhat wonder, that the followers of *Ariſtotle* ſhould not take notice of that famous experiment, which he himſelf delivers, where he teaches, that hot water will ſooner congeal than cold. For, if the matter of fact were true, it would ſufficiently manifeſt, that the heat harboured in the water is deſtroyed, not invigorated, by the coldneſs of the air, that ſurrounds it; ſo that *Themiſtius* muſt, I fear, on this occaſion, take ſanctuary in my obſervation; and, to keep *Ariſtotle* from deſtroying his own opinion, with his own experiment, had beſt ſay, as I do, that it is not true. And though it is not to be denied, that white ſurrounded with black, or black with white, becomes thereby the more conſpicuous; yet it is acknowledged, that there is no real increaſe, or intenſion, of either quality, but only a comparative one, in reference to our ſenſes, obtained by this collation. Nor does a pumice-ſtone grow more dry than it was in the fire or earth, by being transferred into the air or water, and conſequently environed with either of thoſe two fluids, which *Themiſtius* and his ſchools teach us to be moiſt elements; neither will you expect to find a piece of dim glaſs become really more tranſparent, though one ſhould ſet it in a frame of ebony, though that wood be ſo opacous as to be black. And whereas it is commonly alledged, as a proof of the power, nature has given bodies, of flying their contraries, that drops of water falling upon a table will gather themſelves into little globes, to avoid the contrary quality in the table, and keep themſelves from being ſwallowed up by the dry wood; the cauſe pretended has no intereſt in the effect, but little drops of water, where the gravity is not great enough to ſurmount the action of the ambient fluid, if they meet with ſmall duſt upon a table, they do, as they roll along, gather it up, and their ſurfaces being covered with it, do not immediately touch the board, which elſe they would ſtick to. And to ſhew you, that the globular figure, which the drops of water, and other liquors, ſometimes acquire, proceeds not from their flying of dryneſs, but either from their being every way preſſed, at leaſt almoſt equally, (for in ſome caſes alſo they are not exactly round) by ſome ambient fluid of a diſagreeing nature, or from ſome other cauſe, differing from that the ſchools would give; I ſhall deſire you to take notice, that the drops of water, that ſwim in oil, ſo as to be ſurrounded with it, will likewiſe be globular; and yet oil is a true and moiſtening liquor, as well as water. And the drops of quickſilver, though upon a table they are more diſpoſed, than water, to gather themſelves into a round figure; yet that they do it not as humid bodies, is evident, becauſe quickſilver, broken into drops, will have moſt of them globular, not only in oil but in water. And to ſhew you, that it is from the incongruity it has to certain bodies, that its drops will not ſtick upon a table, nor upon ſome other bodies, but gather themſelves into little ſpheres, as if they deſigned to touch the wooden plain but in a point; to manifeſt this, I ſay, we need but take notice, that though the ſame drops will retain the ſame figure on ſtone or iron, yet they will readily adhere to gold, and loſe their globulouſneſs upon it, though gold be a far drier body than wood, which, as far as diſtillation can manifeſt, muſt have in it a ſtore of humid parts of ſeveral kinds, (I mean both watery and unctuous.) But this may reliſh of a digreſſion; my taſk being only to examine the Antiperiſtaſis of cold and heat, concerning which, I think, I had very juſt cauſe to pronounce the vulgar conceit very unconſonant to the nature of inanimate beings. For the Peripateticks talk of cold and heat ſurrounded by the oppoſite quality, as if both of them had an underſtanding, and foreſight, that, in caſe it did not gather up its ſpirits, and ſtoutly play its part againſt the oppoſite, that diſtreſſes it, it muſt infallibly periſh; and as if, being conſcious to its ſelf of having a power of ſelf-invigoration, at the preſence of its adverſary, it were able to encourage itſelf, like the hero in the poet, that ſaid,

See the Hiſtory of Fluidity, Sect. 19.

*Nunc animis opus eſt, Ænea, nunc pectore firmo.*

Which indeed is to transform phyſical agents into moral ones.

ELEUTH. 12. The validity of the Peripatetick argument, drawn from reaſon, conſidered abſtractedly from experience, I ſhall leave *Themiſtius* to diſpute out with you, at more leiſure. And ſince you well know, that the only arguments I alledge to countenance Antiperiſtaſis, were built upon experience, as judging them either the beſt, or the only good ones, I long to hear what you will ſay to the examples, that have been produced of that, which you deny.

CARNEADES. 13. That *Eleutherius*, which I have to anſwer to the examples, that are urged, either by the ſchools, or by you, in favour of Antiperiſtaſis, conſiſts of two parts. For, firſt, I might ſhew, that, as reaſon declares openly againſt the common opinion, ſo there are experiments, which favour mine, and which may be oppoſed to thoſe you have alledged for the contrary doctrine. And, ſecondly, I might repreſent, that of thoſe examples, ſome are falſe, others doubtful; and thoſe, that are neither of theſe two, are inſufficient, or capable of being otherwiſe explicated, without the help of your hypotheſis. But, for brevity's ſake, I ſhall not manage theſe two replies apart, but mention, as occaſion ſhall ſerve, the experiments, that favour my opinion, among my other anſwers to what you have been pleaſed to urge on the behalf of *Ariſtotle*.

14. To begin then with that grand experiment, which, I remember, a late champion for Antiperiſtaſis makes his leading argument to eſtabliſh it, and which is ſo generally urged on that occaſion; I mean, the heating of quick-lime in cold water: I confeſs, I cannot but admire the lazineſs and credulity of mankind, which have ſo long, and generally, acquieſced in what they might ſo eaſily have found to be falſe. This I ſay, becauſe I was poſſibly the firſt, that has had both the curioſity and boldneſs to examine ſo general and conſtant a tradition; yet I doubt not, that you will ſoon be brought to take it, as well as I, for as great, as popular, an error. For, to let you manifeſtly ſee, how little the incaleſcence of the quick-lime needs be allowed to proceed from the coldneſs of the ambient water, if, inſtead of cold water, you quench it with hot water, the ebullition of the liquor will not only be as great, as if the water were cold, but oftentimes far greater. As I have ſometimes, for curioſity, removed boiling water from the fire; and when the liquor had left off boiling, but was yet ſcalding hot, I put it into a convenient quantity of quick-lime; and, after a

while, the water, which, as I ſaid, had ceaſed from boiling, began to boil afreſh, with ſo much vehemence, and ſuch large and copious bubbles, that it threatened to run over the pot, of which, before the efferveſcence, a conſiderable part was left unfilled. And this was no more, than what I might well look for, hot water being much fitter than cold, to pervade nimbly the body of the lime, and haſtily diſſolve, and ſet at liberty the igneous and ſaline parts, wherewith it abounds. And how much a greater intereſt ſalts may have in ſuch incaleſcencies, than cold, I have alſo taken pleaſure to try, by pouring acid ſpirits, and particularly ſpirit of ſalt, upon good quicklime. For, by this means, there would be a far greater degree of heat excited, than if I had, inſtead of ſpirit of ſalt, uſed common water; and this, whether I imployed the ſpirit cold or hot. For in either caſe, ſo ſmall a portion, as about the bigneſs of a walnut of lime, put into a ſmall glaſs, would, by the addition of a little ſpirit of ſalt, put to it by degrees, both hiſs and ſmoak, and boil very ſurprizingly; and, notwithſtanding the ſmall quantity of the matter, would conceive ſo great a heat, that I was not able to hold the glaſs in my hand. And to ſhew ſome friends, how little heat excited in quick-lime by cold water proceeds barely from the coldneſs of that liquor, I cauſed a parcel of good lime to be beaten ſmall, and putting one part of it into a glaſs veſſel, I drenched it plentifully with oil of turpentine, more than it would imbibe, and the other portion of the lime I likewiſe drenched with common water: both theſe liquors having ſtood in the ſame room, that they might be reduced by the ſame ambient air, to a like degree of coldneſs, the event of this trial was (what I looked for) that the oil of turpentine, notwithſtanding its actual coldneſs, and the great ſubtilty and piercingneſs of parts, which it has in common with other chymical oils, being of an incongruous texture, ſeemed not to make any diſſolution of the powdered lime, and did not, for ſeveral hours, that I kept it, produce, that I perceived, any ſenſible heat in the lime. Whereas, to ſhew, that it was not the fault of the lime, that part of it, on which common water had been poured, did, after a little while, conceive ſo ſtrong a heat, that it broke a large open-mouthed glaſs, into whoſe bottom it was put; and not only grew ſo hot, that I could not endure to hold it in my hand, but ſent out at the mouth of the glaſs, though that were conſiderably diſtant from the lime, a copious white fume, ſo hot, that I could not well ſuffer the holding of my hand over it. And, to prevent a poſſible, though invalid objection, which I foreſaw might be drawn againſt the experiment made with oil of turpentine, from the oleaginous nature of that liquor, I covered a piece of the ſame ſort of quick-lime, I have been ſpeaking of, with highly rectified ſpirit of wine: but though I left them together all night, yet I perceived not, that the liquor had at all ſlacked the lime, which continued in an entire lump, till, upon the ſubſtituting of common water, it did, as I remember, quickly appear to be ſlacked, ſince it fell aſunder into a kind of minute white powder, which was (bating the colour) almoſt like mud, and would eaſily, by a little ſhaking, be diſperſt, like it, through the water.

ELEUTHERIUS. 15. I ingenuouſly confeſs to you, *Carneades*, that what you ſay ſurprizes me; for I thought it ſuperfluous to try my ſelf ſo acknowledged an experiment, being not able to imagine, that ſo many learned men, for ſo many ages, ſhould ſo unanimouſly, and confidently, deliver a matter of fact, of which, if it were not true, the falſity could be ſo eaſily diſcovered.

CARNEADES. 16. For my part, *Eleutherius*, I confeſs, I am wont to doubt of what they teach, that ſeldom or never doubt. And I hope you will forgive me, if, having found an aſſertion ſo general and uncontrouled, of a falſity ſo eaſy to be diſproved, I be inclinable to ſuſpect the truth of their other inferiour traditions about

Antiperiſtaſis; and of theſe I will mention the two chiefeſt I have met with among the moderns, (for being contrived experiments, I preſume you will eaſily believe, they came not from *Ariſtotle*, nor the ancient ſchoolmen, that commented upon him.)

17. THE firſt of theſe is the freezing a pot to a joint ſtool, by a mixture of ſnow and ſalt, by the fire's ſide; in which caſe it is pretended, that the fire does ſo intend the cold, as to enable it to congeal the water, that ſtagnated upon the ſurface of the ſtool, betwixt that and the bottom of the pot. But how little need there is of Antiperiſtaſis in this experiment, you may gueſs by this, that I have purpoſely made it with good ſucceſs in a place, in which there neither was, nor ever probably had been, a fire, the room being deſtitute of a chimney. And this trial of mine I could confirm by divers other experiments of the like nature, but that this one is ſufficient.

18. I PROCEED therefore to the other experiment, which is delivered by very learned men, and for whom I have a great reſpect: according to theſe, if you take a ſomewhat large pot, and having filled it almoſt with ſnow, place in the middle of the ſnow a phial full of water; this pot being put over the fire, the coldneſs of the ſnow will be ſo intended by the heat, from which it flies into the water, that it will turn that liquor into ice. But though I ſeveral times tried this experiment, yet neither in earthen, nor in ſilver veſſels, could I ever produce the promiſed ice. And I remember, that an eminently learned man, that wondered to find me ſo diffident of what he ſaid, he knew to be true, readily undertook to convince me, by an ocular proof; but with no better ſucceſs, than I had before. So that the argument may be plauſibly enough retorted upon them, that urge it.

19. AND in caſe the trial ſhould ſucceed ſome time or other, (for that it doth not ordinarily, I have ſhewn already) yet will there be no neceſſity of deriving the effects from Antiperiſtaſis. For though, in ſuch caſes, the fire would contribute to the production of the effect, by haſtening the diſſolution of the ſnow; yet the heat of the fire does but remotely, and by accident, cauſe the production of ice, ſince other agents will do the ſame thing, that are qualified to make a quick diſſolution of the ſnow, whether they be hot or no; as I have tried, that ſpirit and crude ſalt of nitre will either of them, by a due application, bring ſnow, by diſſolving it, to congeal water, though the ſpirit and the nitre be generally agreed upon to be actually cold, and one, if not both of them, to be potentially cold too.

20. HAVING thus diſpatched the experiments, pretended to evince an Antiperiſtaſis, I muſt now examine the obſervations, that are alledged to that purpoſe, of which the principal, if not the only, are theſe; the coldneſs of the middle region of the air; the increaſe of mens ſtomachs in winter; the generation of hail; and the heat and cold in cellars, and other ſubterraneal places, when the contrary quality reigns in the air.

21. To begin with the firſt of theſe: I will not now diſpute, whether the ſecond region of the air have really that coldneſs, that is wont to be aſcribed to it; though our friend Mr. *Boyle* ſeems to doubt, whether that region's being always and every where cold, hath been as ſtrongly proved, as aſſerted. But paſſing over that queſtion, I ſee no need of imploring the help of Antiperiſtaſis, to keep the ſecond region of the air for the moſt part cool. For without at all taking in the cauſe imagined by the ſchools, an obvious and ſufficient one may be eaſily aſſigned. For the air being, as to ſenſe, cold of its own nature, ſo that when we feel it hot, it is made ſo by ſome adventitious agent; and that agent being for the moſt part the ſun, who heats the air chiefly, though not only, by its reflected beams; their heat is ſo languid, by that

time they arrive, diſperſed, at the ſecond region of the air, that they are not able to overpower its natural coldneſs, increaſed perchance by ſome frigorifick ſpirits, that may find a more commodious harbour there, than in other parts of the atmoſphere. And whatever be the true cauſe of the coldneſs in the middle region of the air, I cannot but admire to find that coldneſs ſo confidently aſcribed to Antiperiſtaſis, by *Themiſtius* and his friends the Ariſtotelians: for, according to them, it is the nature of the element of air to be as well hot as moiſt, and according to the ſame Peripateticks, both the upper region of the air always, and the lower in ſummer is hot: the former by the neighbourhood of the imaginary element of fire, and the latter by the reflexion of the ſun-beams from the earth: which two poſitions being laid together, I would fain learn of any Ariſtotelian, how Antiperiſtaſis comes to take place here? For, according to them, thoſe bodies have their cold and heat increaſed by Antiperiſtaſis, that are on both hands aſſailed by bodies of a contrary quality, to that which is natural to the ſurrounded body: whereas the whole element of air, and conſequently the middle region, being, as they would perſuade us, hot, of its own nature; what ſhadow of probability is there, that the higheſt and loweſt regions, by being hot, ſhould make the middle region, which is alſo naturally hot, intenſely and durably cold? But though the objection is ſo clear, that it needs not to be inſiſted on; yet, becauſe it is but an argument *ad hominem*, I ſhall add this, for their ſakes, that are not in this point Peripateticks: that it does not appear to me, that if the air be naturally rather cold than hot, the ſecond region muſt owe the intenſeneſs of that quality to an Antiperiſtaſis. For the ground of the opinion, I oppoſe, being this, that both the firſt and the third regions are conſiderably hot, I would gladly find it proved as to the upper region. I confeſs, I have not found the aſſertion contradicted; but that as little convinces me, as the uncontrouledneſs of the tradition about quicklime, that I lately confuted. It is true, there are two reaſons alledged, to evince the heat of the ſupreme region of the air, but neither of them to me ſeems cogent. For the firſt is, that the vicinity of this region to the element of fire makes it partake a high degree of heat. But if we conſider the diſtance of that element, which they place contiguous to the orb of the moon, and how little nearer to it the concave part of the upper region is, than the convex of the middle, we may eaſily conceive, that in two diſtances, that are both of them ſo immenſe, ſo ſmall a diſparity cannot be much (if at all) more conſiderable, than the greater nearneſs of one ſide of a ſheet of paper, held at three yards diſtance from an ordinary fire, in compariſon of the diſtance of the other ſide of the ſame paper; or than the diſtances of a ſmall wart, and of the neighbouring parts of the face, when a man comes within two or three yards of the fire. But it is not worth while to proſecute this conſideration, becauſe the argument againſt which it is alledged, is built upon the groundleſs ſuppoſition of the element of fire, a figment, which many of themſelves do daily grow aſhamed of, as indeed its exiſtence is as little to be diſcovered by reaſon, as perceived by ſenſe.

22. THE other argument for the heat of the third region of the air is, that fiery meteors are kindled by it. But not now to queſtion, whether all meteors, that ſhine, and therefore paſs for fiery, are really kindled exhalations; we ſee, that in the lower region of the air, and in winter, thoſe fires, which are called either *Helena*, or *Caſtor* and *Pollux*, are generated in great ſtorms, and hang about the ſails and ſhrouds of ſhips. Nay, do we not much more frequently ſee, that lightning is produced at all ſeaſons of the year? for in warmer countries thouſands have obſerved it to thunder (and ſo have I in winter) in the middle region of the air. And ſince it is not the heat of the inferiour part of the air, that kindles thoſe exhalations; and if

notwithſtanding

notwithſtanding the coldneſs of the ſecond region, fiery meteors may be frequently generated there; I ſee no reaſon why the production of ſuch meteors ſhould argue the heat of the third region of the air. And if that region be not hot, then it will, I preſume, be eaſily granted, that the coldneſs of the ſecond muſt very improperly be attributed to ſuch an Antiperiſtaſis, as it is generally aſcribed to.

23. I COME next to conſider that aphoriſtical ſaying of *Hippocrates*, *Ventres hyeme eſſe calidiores*, together with the obſervation, whereon it ſeems to have been grounded. I will not now examine, whether any arguments for the contrary may be drawn from the heat and thirſt men feel in ſummer, and the refreſhment they then find by drinks and fruits, and other aliments that are actually cold. For that, which I principally intended to ſay, is this, that I much more doubt the matter of fact delivered in the aphoriſm, than that, in caſe it be true, it may be made out without the help of Antiperiſtaſis, in the vulgar and ſcholaſtic notion of that term.

24. I CONSIDER then firſt, that the proof, that is wont to be brought of the greater heat of men's ſtomachs in winter, is, that men are wont to have then a greater appetite to their meat. But though I pay ſo much reſpect to the great *Hippocrates*, as to allow the aphoriſm in a ſenſe; yet I admit it to be true but upon an hypotheſis, that I do not admit to be ſo. For the aphoriſm ſuppoſes, that the digeſtion of meat in the ſtomach is made by heat; and conſequently, that the ſtronger digeſtion, that is wont to be made in winter, is an argument of the ſtomach's being then hotter, than at other ſeaſons of the year. But the erroneouſneſs of this ſuppoſition, I think, I need not ſolemnly prove to *Eleutherius*, who, I doubt not, has taken notice of ſeveral things in nature, that agree not with it, and particularly of the ſtrong concoction, that is made in the ſtomachs of divers ravenous fiſhes, whoſe ſtomachs and blood are yet, as I have purpoſely obſerved, ſenſibly cold: but if it ſhould in ſome caſes prove true, that there is really in men's bodies a far greater heat in winter than in ſummer, yet this would not infer an Antiperiſtaſis in the ſenſe, wherein I oppoſe it. For the vital heat lodged in the heart, always generating out of the blood and juices, that continually circulate through that part, great ſtore of ſpirits and warm exhalations, which are wont to tranſpire through the pores of the ſkin in much greater quantities, than, notwithſtanding the affirmations of *Sanctorius*, any thing but my own trials could have perſuaded me; theſe warm ſteams finding the pores of the ſkin ſtraitened and ſhut up, grow more and more copious in the body, and thereby heat the ſtomach, as well as the other internal parts of it: and perhaps alſo the ſame frigorifick corpuſcles or temperature of the air, that produce cold in winter, may, by ſhutting in certain kinds of effluvia, or perhaps altering the motion or texture of the blood, reduce it to ſuch a diſpoſition, as that the appetite ſhall be increaſed, as well as the concoction in the ſtomach promoted by the ſtomachical menſtruum, or ferment, which either is newly generated in winter, or more copiouſly ſupplied (by the circulating of the blood to the ſtomach) in that ſeaſon than in others. And to ſhew, that a good appetite may be procured by agents endowed with very diſtinct and contrary qualities; do not we ſee, that ſpicy ſauces, wine and vinegar, do all of them, in moſt men, beget an appetite, though the two former be confeſſedly hot, and the latter cold? And ſo wormwood and juice of lemons have both of them frequently relieved dull and weak ſtomachs, though the one be confeſſedly a hot ſimple, and the other a cold. And in ſome caſes either the frigorifick corpuſcles themſelves, and perhaps ſome other unknown to us, that they may bring along with them, may ſo ſollicit the ſtomach, as to breed an eager appetite, not preciſely by their being cold or hot, but

by their peculiar nature; as we have inſtances of ſome, that in theſe parts by walking on the ſnow, procure to themſelves a bulimia. And the learned *Fromundus* relating, how he himſelf, by walking along on the ſnow, was ſurprized with ſuch a *Βȣλιμία*, takes notice, that the chief cauſe of the fainting was in the ſtomach; and that he found by his own experience, that that part was diſcompoſed, convelled, and provoked to caſt. To which he adds, (what makes much for my preſent purpoſe) that he thinks now the chief cauſe of the bulimia to conſiſt in certain ſteams, that do peculiarly affect the ſtomach, which they gnaw and diſtend. And juſt before he obſerves, that ſtraining to fetch deep coughs is a preſent remedy in this diſtemper, by diſcharging the ſtomachs and lungs of thoſe ſnowy ſpirits, which were either attracted in reſpiration, or had ſome other way inſinuated themſelves in thoſe parts: ſo that beſides the cold abſtractedly conſidered, the ſtomach may be peculiarly affected by other, either attributes or concomitants, of the frigorifick corpuſcles, that grow powerful in froſty weather; with which it well agrees, that divers have been obſerved to be ſubject to bulimias in theſe parts of the world, though in our warmer climates ſuch men endure nothing near ſo great a cold, nor are ſo much inconvenienced by it, as multitudes of others, that in *Nova Zembla*, and other gelid regions, never complained of having contracted, even in the midſt of winter, any ſuch diſeaſe.

25. ANOTHER argument, that is ſpecious enough, urged in favour of Antiperiſtaſis, is borrowed from the production of hail, which is preſumed to be generated in ſummer only, not in winter; and, according to *Ariſtotle*, and the ſchools, is made in the loweſt region of the air, by the cold of the falling drops of rain ſo highly intended by the warmth it meets with in the air near the earth, as to congeal the water, wherein it is harboured. But though I freely confeſs to you, that I think the generation of hail difficult enough to be ſolidly explicated; yet I ſcruple not to reject the received doctrine about it, for ſeveral reaſons, of which I will now name four.

26. FOR in the firſt place, it is not univerſally true, as is ſuppoſed, and the Ariſtotelian doctrine requires, that hail falls not but in ſummer, or very hot weather. For I have myſelf obſerved it within this twelvemonth, to hail at the latter end of *November*, and that, when ſome froſty days have preceded, and when the coldneſs of the weather was complained of. Nay, the longeſt ſhower of hail, that either I, or ſome others, remember ourſelves to have ever known, I obſerved to fall about a week before the end of *January*, on a night preceded by a very froſty day, which itſelf was preceded by a ſharp fit of froſty weather. And here I muſt not pretermit this circumſtance, that when the tedious ſhower was over, there came to the houſe, where I then was, a maid, that is ſervant to one of my domeſticks, and related to her maſter, and others, how ſhe was for a good while miſled out of the beaten way, where the ſtorm found her, by an *Ignis fatuus*, which ſhe followed, till by its paſſing over a place, where ſhe found an unpaſſable hedge, it both ſhewed her, that ſhe was out of her way, and that it was no candle, though ſhe had ſo confidently thought it one, that ſhe called out to the party, ſhe preſumed it to be carried by. I will leave *Themiſtius* to unriddle, how the nocturnal air could kindle a fiery meteor by its coldneſs, and at the ſame time congeal the falling drops of water into ice by its warmth; and ſhall only add, that I doubt not but other obſervations of the like kind have been often made, though perhaps ſeldom recorded. For within the compaſs of a very few weeks of the ſtorm, ſome ſervants of mine affirmed themſelves to have obſerved it to hail two or three times, beſides that already mentioned.

27. NEXT, if *Ariſtotle* have rightly aſſigned the cauſe of hail, it is ſomewhat ſtrange it ſhould not fall far more frequently in ſummer, and eſpecially in hot climates, than it does, conſidering how often in all probability the drops of rain fall cold out of the ſecond region into the warm air of the firſt. And more ſtrange it is, that even in thoſe parts of *Egypt*, where it rains frequently enough and plentifully (for ſo *Proſper Alpinus*, that lived long there, aſſures us it does) though not about *Grand Cairo*, yet about *Alexandria* and *Peluſium*, it ſhould never hail no more than ſnow, as the ſame learned phyſician (a witneſs above exception) affirms. Beſides, whereas it is pretended, that ſnow is generated in the upper region of the air, and hail always in the lower; my own obſervation has afforded me many inſtances, that ſeem to contradict the tradition. For I have obſerved in I know not how many great grains of hail, that, beſides, a hard tranſparent icy ſhell, there was as it were a ſnowy pith of a ſoft and white ſubſtance, and this ſnowy part was moſt commonly in the middle of the icy, which made me call it pith, but ſometimes otherwiſe. And laſtly, whereas the favourers of Antiperiſtaſis would have the drops of rain, in their deſcent, to be congealed apart in the ambient air; not to urge, how little the irregular and angular figures, we often meet with in hail, do countenance this doctrine; hail often falls in grains, too great by odds to be fit to comply with *Ariſtotle*'s conceit. For not to mention the grains of hail I have obſerved my ſelf to be of a bigneſs unſuitable to this opinion, divers learned eye-witneſſes have informed me of their having obſerved much greater than thoſe I have done: and particularly an eminent Virtuoſo of unqueſtionable credit affirmed both to me and to an aſſembly of Virtuoſi, that he had ſome years ago, at *Lyons* in *France*, obſerved a ſhower of hail, many of whoſe grains were as big as ordinary tennis-balls, and which did the windows and tiles a miſchief anſwerable to that unuſual bulk. And *Bartholinus* affirms, that he himſelf obſerved, in another ſhower of hail, grains of a more unwonted ſize; a ſingle grain weighing no leſs than a whole pound. But though this it ſelf is little in compariſon of what I remember I have ſomewhere met with in learned authors, yet it may abundantly ſuffice to diſprove the vulgar conceit about the generation of hail, till we meet in theſe countries with ſhowers of rain, whoſe ſingle drops prove to be of ſuch a bigneſs; which I preſume thoſe, that aſcribe hail to Antiperiſtaſis, will not eaſily ſhew us.

28. I COME now to conſider the laſt, and indeed the chiefeſt example, that is given of Antiperiſtaſis; namely, the coldneſs of cellars, and other ſubterraneal vaults in ſummer, and their heat in winter. And as the argument, wont to be drawn from hence, conſiſts of two parts, I will examine each of them by it ſelf.

29. AND firſt, as to the refreſhing coldneſs, that ſubterraneal places are wont to afford us in ſummer, I both deny, that they are then colder than in winter; and I ſay, that though they were, that coldneſs would not neceſſarily infer an Antiperiſtaſis.

30. WE muſt conſider then, that in ſummer our bodies having for many days, if not ſome weeks, or perhaps months, been conſtantly environed with an air, which, at that ſeaſon of the year, is much hotter, than it is wont to be in winter, or in other ſeaſons, our ſenſes may eaſily impoſe upon us, and we may be much miſtaken, by concluding upon their teſtimony, that the ſubterraneal air we then find ſo cool, is really colder than it was in winter, or at the ſpring; as they that come out of hot baths think the air of the adjoining rooms very freſh and cool, which they found to be very warm, when coming out of the open air, they went through thoſe warm rooms to the bath, and the deepneſs and retiredneſs of theſe ſubterraneal caves keep the air, they harboured, from being any thing near ſo much affected with the changes of the ſeaſon, as the outward air that is freely expoſed to the ſun's warming beams, which pierces with any ſenſible force ſo little away into the ground, that diggers are

not wont to obſerve the earth to be dried and diſcoloured by them beyond the depth of a very few feet. And I have found, that in very ſhallow mines not exceeding ſix or ſeven yards in depth, though the mouth were wide, and the deſcent perpendicular enough, the air was cool in the heat of ſummer; ſo that the free air and our bodies, that are always immerſed in it, being much warmer in ſummer than at other times, and the ſubterraneal air, by reaſon of its remoteneſs from thoſe cauſes of alteration, continuing ſtill the ſame, or but very little changed, it is no wonder, there ſhould appear a difference as to ſenſe, when our bodies paſs from one of them to another.

31. AND ſuppoſing, but not yielding, that the air of cellars and vaults were really colder in ſummer than in winter, that is, were diſcovered to have a greater coldneſs, not only as to our ſenſe of feeling, but as to weather-glaſſes; yet why ſhould we for all that have recourſe, for the ſolution of the difficulty, to an Antiperiſtaſis, which it is much harder to underſtand, than to find out the cauſe of the phænomenon, which ſeems in ſhort to be this; that whereas (which I ſhall ſoon have occaſion to manifeſt) there are warm exhalations, that in all ſeaſons are plentifully ſent up by the ſubterraneal heat, from the lower to the ſuperficial parts of the earth, theſe ſteams, that in winter are in great part repreſſed, or checked in their aſcent, by the cold froſt or ſnow, that conſtipates the ſurface of the earth, and choaks up its pores; theſe exhalations, I ſay, that being detained in the ground would temper the native coldneſs of the earth and water, and conſequently that of ſprings, and of the ſubterraneal air, are by the heat, that reigns in the outward air, called out at the many pores and chinks, which that heat opens on the ſurface of the ground, by which means the water of deep ſprings and wells, and the ſubterraneal air, being deprived of that, which is wont to allay their native or wonted coldneſs, are left to diſcloſe a higher degree of it, and ſeem to have that quality increaſed, when indeed it is but freed from the mixture of its contrary, that weakened it.

32. As for the heat, we find in cellars and vaults in winter, the ſolutions already given will be applicable to that phænomenon alſo, which by this way is yet more eaſy to be accounted for than the other. For having firſt queſtioned the matter of fact, it will not be difficult to ſhew, that, though it were true, it need not be aſcribed to Antiperiſtaſis.

33. I THINK then, that it may be juſtly queſtioned, whether cellars in general are hotter in winter than they are in ſummer. For as for the teſtimony of our ſenſes, upon which alone men are wont to conclude the affirmative, it may in this caſe eaſily and much delude us. For thoſe places being ſheltered from the winds, and kept from a free communication with the outward air, are much leſs expoſed than others to the action of thoſe agents, whatever they be, that produce cold in the air. So that our bodies being conſtantly immerſed in the air refrigerated by the winter, and conſequently brought nearer to the temper of that air, when we bring thoſe bodies into cellars, the ſubterraneal air muſt ſeem warm to us, though in it ſelf it were unvaried as to its temper.

34. Now that many cellars are indeed colder in the midſt of winter, than in the heat of ſummer, though not in reſpect of our ſenſes, yet in reſpect of other bodies, that have not the ſame prediſpoſitions, I am induced to believe by ſome experiments of mine own, purpoſely made. And firſt in a froſty evening having hung out in a garden two ſealed weather-glaſſes, that they might be reduced as near as could be to the temper of the ambient air, I brought one of them into a cellar, and it ſoon began manifeſtly to riſe, and in two or three hours aſcended five or ſix diviſions, whilſt the water in another ſealed weather-glaſs, that continued ſuſpended in the ſame

part of the garden, did rather a little ſubſide, than at all riſe, which is agreeable to the firſt part of what I was ſaying; namely, that the air, harboured in cellars, is not ſo powerfully affected by the ordinary efficients of cold, as the free and external air. And now as to the ſecond part of what I was ſaying, that the ſubterraneal air, though it be leſs affected by the outward cold, may be ſomewhat affected by it, inſtead of growing hotter by Antiperiſtaſis; I ſhall add, that early in the morning in froſty weather the liquor in the ſame weather-glaſs appeared more ſubſided, than over night, which ſhews, that the external air did leſſen, not increaſe the warmth of the air in the cellar. And having there placed a wide-mouthed glaſs of oil, which in thawing weather remained all night fluid as before, the ſame liquor, the very next night, which was a bitter froſt, was ſo far frozen and congealed, as to ſink in other oil, and keep its ſurface exactly, though the glaſs were inclined and turned upſide down. And proſecuting my trial, I found, that in a ſharp froſt, and great ſnow, the liquor, that on the Thurſday night was beneath the fourth knub or mark of diviſion, a ſudden thaw coming with a ſouth wind, the next morning in the ſame cellar the liquor was aſcended to the eighth mark. And continuing the weather-glaſs in the ſame cellar for a good while, to watch its alterations every night and morning, I remember I met with, and regiſtered more obſervations, that confirmed me in my opinion, though it is ſo long ago, that I have forgot the particular circumſtances. And after theſe trials meeting with a learned Polander, I did, without declaring my opinion, inquire of him, whether in his country he had at any time obſerved beer to freeze in cellars in froſty weather; to which he anſwered, that in the coldeſt winters, if the beer were ſmall, the barrels would oftentimes be frozen, but not if it were ſtrong. But I need not have recourſe to foreign teſtimony, having my ſelf obſerved here in *England*, more than one barrel of beer to be frozen in the cellar in exceeding cold weather. Inſomuch that one of the barrels being full, and the liquor expanded by freezing, was forced out at certain chinks, which ſeem to have been made by that expanſive force, and the liquor ſo ejected, adhered in a conſiderable lump to the outſide of the veſſel; and yet this cellar had its windows carefully ſhut, and not only was near a kitchen, where fire was conſtantly kept, but, which was more conſiderable, it had this principal mark of being a good cellar, that in the heat of ſummer it uſed to afford me drink ſufficiently cool. And now to requite *Eleutherius* with the teſtimony of that very perſon, phyſician to the Ruſſian emperor, whoſe authority he alledged againſt me, I ſhall confeſs, that as he ſuſpects I had conference with this doctor, and when I diligently enquired of him, whether their cellars at *Moſcow* were really very cold in ſummer, he anſwered me, that they were not, and that they had diſtinct cellars for ſummer and for winter; that their ſmall beer would quickly grow ſour in their cellars in ſummer, if their veſſels were not kept in ſnow; that therefore their way was to make at the bottom of their ſummer cellars (to which belonged a well, to receive the water dropping from the melted ſnow) a deep layer of ſnow, on which they afterwards caſt a convenient quantity of water, that the whole maſs might be turned into a kind of ice. In this ſnow they keep their caſks, making ſometimes a layer of ſnow, and a layer of caſk, and digging out their veſſels, as they had occaſion to uſe them. By all which it may appear, how groundleſly it is univerſally affirmed of cellars, that as they ſeem to the ſenſe, ſo they really are hotter in winter than in ſummer.

35. But if it ſhould happen, (as in ſome places it is not impoſſible, but that it may) that ſome vaults and cellars are really warmer in ſummer than in winter; yet I ſee not, why this ſhould reduce us to the acknowledgement of an Antiperiſtaſis; for

neither could the effect be made out by that, nor would there be any neceſſity to have recourſe to it.

36. AND firſt I might content myſelf to repeat, what I have formerly ſaid, to ſhew the incongruity of Antiperiſtaſis in general to nature's ways of acting. And I might add, that to imagine with ſome late Peripateticks, (whom all their reverence to *Ariſtotle* has not ſo far blinded, as not to let them ſee the unreaſonableneſs of his conceit) that in winter the warmth of the ambient air retreats into cellars and vaults to ſhun its contrary, is to make meer accidents, or at beſt inanimate agents, act with knowledge and deſign. But I will rather repreſent, that, though Antiperiſtaſis were intelligible, it were improper to alledge it in our caſe. For to invigorate the warmth of the air by the cold, the air muſt, according to them, be environed with other cold bodies, and the heat muſt retire it ſelf as far as it can from them. And accordingly it is obſerved, that in winter the deepeſt cellars are warmeſt; but in the caſe before us the ſubterraneal air, though above, it have the cold that reigns in winter; yet beneath, the ſubterraneal heat makes the earth very warm. This I ſhall not wonder, if you look upon, as new and paradoxical: and therefore I ſhall apply myſelf to the proof of it, and to convince you, I ſhall not imploy the obſervations of chymiſts and mineraliſts, for fear you ſhould ſuſpect them of ignorance or deſign; but I will uſe only the authority of a learned phyſician, who, I think, was alſo a profeſſor of mathematicks, who, in but too many points, is a ſtout Peripatetick, and who, above all this, profeſſes himſelf to be an eye-witneſs of what he relates. This author then informs us, that about the year 1615, he had a curioſity to viſit the mines of *Hungary*, and particularly to go down into the deep golden mine at *Cremnitz*; and that after he had deſcended fourſcore or a hundred fathoms, he found it exceſſively hot, though he had but a ſlight linen garment on; and though he be a maintainer of Antiperiſtaſis, yet he affirms, that not only the overſeer and workmen of that mine, but alſo thoſe of divers other mines, unanimouſly aſſured him, that that lower region of the earth was all the year long very hot, and as well in winter, as he found it in ſummer. So that it ſeems, in winter the heat of the ſubterraneous parts leſs remote from the ſuperficies, cannot be intended by the coldneſs of the more internal parts of the earth, thoſe parts being themſelves not always cold, but always hot.

ELEUTHERIUS. 37. But you may, *Carneades*, remember, that this very author tells you [*], that he found the ſupreme region of the earth, as he calls it, which is that next the air, exceedingly cold, both as he went down into the mine, and as he came up again, and that he aſcribes that coldneſs to Antiperiſtaſis.

CARNEADES. 38. Right, but you may remember too, that he relates [†], that it was in *July*, and in very hot weather, that he went down into the mine, and that, to avoid fouling his clothes, he put them off, and exchanged them for a light looſe linen garment, ſuch as the diggers wore; and this himſelf mentions, as that which much increaſed the coldneſs he felt. So that, if, beſides this, we conſider, that he deſcended into a cooler place, with a body already affected with the great heat which he elſewhere takes notice, that that ſeaſon had given the outward air, and perhaps much heated by riding or walking to the mine, we ſhall not wonder, that he found the change very ſenſible as he went down. And we ſhall leſs wonder, that he found the upper region of the earth, as he calls it, more cold, when he came up again; ſince, beſides the toil of going to and fro, and aſcending through narrow, low, and difficult paſſages, he came out of a place exceſſively hot; inſomuch that he tells us, that the overſeer of the mine would not go back with him the ſame way he came, but took a far ſhorter, though it were a more dangerous way, cauſing himſelf to be drawn up in a perpendicular groove; and rendering this reaſon, that it was very unhealthy, when one comes out of a place, where the diggers work naked, and where one is even melting into ſweat, to make any long ſtay in the ſuperiour region of the earth. So that beſides that this author, altho' he maintains Antiperiſtaſis, yet he allows this upper region to be hot in winter, as well as cold in ſummer; and conſequently, that in winter it has not a cold region beneath, as well as above it; which is enough to vindicate the thing, for which I firſt alledged his teſtimony: Beſides this, I ſay, to me, who, though I willingly thank him for his narrative, am much more ſwayed by what he relates, than by what he thinks; the matter of fact ſeems very favourable to my opinion: for you ſee, that I can juſtly refer the cold he felt near the ſurface of the earth, to the deception of his ſenſe, but the heat he felt within the bowels of the earth cannot be referred to the ſame cauſe; ſince he tells us, that at the top of that great and perpendicular groove, by which the mine-maſter was drawn up, there aſcended a plentiful ſmoke, that was, even above the mouth of it, felt actually hot: and, beſides his own confeſſion, that the deep parts of the mine were more than ſeemingly hot, I can draw further proofs from theſe two circumſtances, that I have elſewhere met with, in his narrative; the one, that on the ſurface of the earth, it was then exceſſively hot; another, that the * ſmoke, which, notwithſtanding this heat, appeared hot, had in its aſcent paſſed through four or five hundred foot of a cold region of the earth, whereby it may well be ſuppoſed, to have been much infrigidated. To theſe relations of the learned *Marinus*, I will add, that the archbiſhop of *Upſal* affirms †, that in the year 1528, being in *Poland*, he went to viſit thoſe deep mountains (as he terms them) whence they dig ſolid ſalt, and having deſcended fifty ladders, found, in the deeper places, that the workmen were naked, becauſe of the heat. So that ſuppoſing the time of the year not to be conſiderable in this caſe, it ſeems by this relation, that, provided a man deſcends low enough into the bowels of the earth, he will find it very hot, even in places that want thoſe metals, or marchaſites, or other like mineral ſubſtances, by the action of ſaline liquors, or exhalations, upon which you, *Eleutherius*, have, I remember, ſometimes ſuſpected, that the heat obſerved in mines may be produced.

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[*] — *Cæpimus in hanc fodinam per gradus valde ſtrictos profundè admodum deſcendere, per regionem certè frigidiſſimam, quam ſolis veſtibus metallicis opertus, multo frigidiorem ſenſi*, &c. p. m. 130.

[†] — *In quam deſcendi menſe Julio, quo anni tempeſtas vigebat calidiſſima, ſicciſſimaque.* p. m. 130.

39. I HAVE hitherto ſhewn, that the heat of cellars and vaults in winter has been very improperly, and now I come to ſhew, that it has been as unneceſſarily aſcribed to Antiperiſtaſis. For as the air of thoſe places is protected from the greateſt part of the adventitious coldneſs, that reigns in the outward air, ſo the ſubterraneal air has a poſitive cauſe of heat in winter, that it has not in ſummer. For, as I formerly took notice, in ſummer the pores of the earth, being dilated and opened by heat, the warm exhalations, that were wont to be mingled with moiſt vapours in the bowels of the earth, are called out, and exhaled away. For as in the winter, the ſurface of the earth being hardened by froſt, or the pores of it choaked up, or at leaſt much obſtructed, the hot ſteams, that, as I lately proved by our French author's teſtimony (to which I could add that of eminent chymiſts and mineraliſts) do continually, and

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* *Exhalatio aëre levior per ipſum puteum aſcendit magno impetu, in ejus ſummitate adhuc ſenſibiliter calida ipſa æſtate, licet ſupremam terræ regionem tunc frigidiſſimam permeat.* Pag. 128. See alſo page 125.

† *In Polonia vero montes profundiſſimi ſalis ſunt, præſertim in Vieliſca & Bochna, ubi videndi cauſâ tranſcenſis ſcalis, vidi in profundioribus locis laboratores nudos ob calorem, ferreis inſtrumentis eruere opulentiſſimum theſaurum ſalis, veluti aurum & argentum ex mineris inexhauſtis.* Olaus Mag. lib. 13. p. 382.

copiouſly enough aſcend from the warm region, or lower parts of the earth, are in great part detained and impriſoned in cellars, and other ſubterraneal cavities, where conſequently they produce ſuch a heat, as to thoſe, that come out of the cold air, may be very ſenſible. And the rather, becauſe whilſt men, by the coldneſs of the ſeaſon, are more than ordinarily careful, to ſtop up the paſſages, at which the external air may get in, they do, though deſignleſly, ſtop up the vents, at which the ſubterraneous exhalations might get out. And to ſhew you, that this laſt circumſtance is not impertinently taken notice of, I ſhall tell you, that a very grave author having occaſion to mention cellars, relates it, as a practice in divers houſes of a town, where he had been, to keep vents in their deep cellars, which in the ſummer were from time to time opened, partly to keep the places ſweet and wholeſome, and partly to let out the warm exhalations, that would elſe hinder their liquors from keeping ſo freſh, and well. And theſe ſteams were affirmed to have been ſeveral times taken notice of, to aſcend viſibly into the free air like a ſmoke; which ſeveral phænomena, and particularly what I formerly related of the hot fumes, that manifeſtly aſcended out of the great groove in the Hungarian mine, may keep us from thinking incredible.

40. AND now, by what I have hitherto diſcourſed, I have made way for the ſolution of a phænomenon, that is wont to be much urged in favour of Antiperiſtaſis; namely, the ſmoaking of water, that is drawn in froſty weather out of deep wells and ſprings.

41. BUT, firſt, I muſt advertiſe you, that it is improperly enough, that ſome urge for Antiperiſtaſis ſuch examples, as the ſtrange ſpring near the temple of *Jupiter Ammon*, which *Lucretius* and others have obſerved to have been exceeding cold in the day-time, and as hot at night: for, not now to examine, whether this ſtory be not fabulous, or might not be aſcribed to ſome crafty trick of the idolatrous prieſts, that had a mind to impoſe upon *Alexander*, as well as others, and procure an admiration to the place; I conſider, that this, and other the like caſes, ſuch as are the ſprings mentioned in the iſlands of *Maldivia*, by *Pyrard* (a French author, that was ſhipwrecked, and lived long in thoſe parts) muſt be referred to the peculiar nature of the ſprings, or ſome other hidden cauſe: ſince, if the water of them were but ordinary, and the phænomena were the effects of Antiperiſtaſis, it might juſtly be expected, that the like ſhould happen in all ſprings, or at leaſt in very many, which, that it does not, common experience ſhews us. And I would ſay, that this might be the caſe of the ſpring, you mention out of Captain *James*'s voyage, (pag. 63.) but that beſides, that he does not ſay expreſly, that it was frozen in *July*, but only, that then it afforded him no water, which might happen upon divers other accounts: and beſides, that it is manifeſt, that in far hotter countries, where the exceſſive heat of the air might more intend the ſubterraneal cold, if Antiperiſtaſis could do it, there is no talk of any ſuch degree of cold in ſummer, as to freeze the ſprings; beſides this, I ſay, there ſeems to be, through ſome miſtake or other, a contradiction in the relation itſelf, ſince in the ſame voyage, ſpeaking of the ſame month of *December*, he expreſly ſays, that their well was then frozen up; ſo, (pag. 58.) *that dig as deep as they could, they could come by no water*. And he complains, on that occaſion, of the unwholeſomeneſs of melted ſnow-water. It is true, that he ſoon after mentions a ſpring, that he found under a hill's ſide, which did not ſo freeze, (pag. 59.) but that he could break the ice and come to it: but by his very ſending far from his houſe to the ſpring, it appears to have been a conſequence, and therefore a proof, of the uſeleſſneſs of his well in *December*; as his affirmation, that it continued all the year ſo, as to be ſerviceable, when the ice was broken, ſhews, that the Antiperiſtaſis did not freeze it

up in ſummer. And having cleared myſelf of ſuch a teſtimony of this ingenious navigator, as would appear very illuſtrious, if there had been no miſtake about it, I ſhall not ſcruple to add, that the late publiſher of the Latin deſcription of *Denmark* and *Norway* informs us, that in or near that little Daniſh iſland *Hueena*, wherein the famous *Tycho* built his *Urani-Burgum*, there is one ſpring among many ordinary ones, that even in the coldeſt winter is never frozen; which, ſubjoins my author, does in theſe regions exceeding rarely happen to be found. *Olaus Magnus* [*] alſo relates, that in another part of the King of *Denmark*'s dominions, namely near *Nidroſia*, one of the chief cities of *Norway*, there is a lake, that even in that northern region never freezes. And the learned *Joſephus Acoſta* mentions [†], that among a very great number of hot ſprings to be met with in *Peru*, *At the baths, which they call the baths of* Ingua, *there is a courſe of water, which comes forth all hot and boiling; and joining unto it there is another, whoſe water is as cold as ice.* He adds, *That the* Ingua (or the Peruvian emperor) *was accuſtomed to temper the one with the other, and that it is a wonderful thing to ſee ſprings of ſo contrary qualities, ſo near one to another.* Theſe relations, as I was ſaying, I ſcruple not to mention, though at firſt ſight they may ſeem to diſfavour my cauſe. For by theſe and ſome others it may appear, that ſprings may obtain very peculiar and ſtrange qualities, from the nature of the places whence they come, or through which they paſs, or from ſome other cauſes, that are as hidden from us, as the originals of theſe rare waters. And this being once proved, who knows what intereſt ſuch cauſes, as we are ſtrangers to, may have in ſome phænomena, that are wont to be wholly aſcribed to the heat and cold of the ſuperficial part of the ground, and what influence they have upon many other ſprings (beſides thoſe above-mentioned) ſome of which, that are very deep, may riſe from the warm region of the earth, where they may be affected by the place, as both theſe and others may be by mineral juices and ſteams, (ſuch, perhaps, as we know nothing of) though we well know, that ſome of them, that are ſaline, without being at all ſenſibly hot, will powerfully reſiſt congelation.

42. But having hinted thus much on this occaſion, I ſhall now proceed to conſider the ſmoking of waters drawn from deep places in froſty weather; and ſhew, that it does not neceſſarily conclude ſuch water to be warmer in winter, ſince that effect may proceed not from the greater warmth of the water in ſuch weather, but from the greater coldneſs of the air. For we may take notice, that a man's breath in ſummer, or in mild winter weather, becomes very viſible, the cold ambient air nimbly condenſing the fuliginous ſteams, which are diſcharged by the lungs, and which in warmer weather are readily diffuſed in imperceptible particles through the air. And I have obſerved, upon the opening of iſſues in ſome men's arms, that though no ſmoke be viſible in ſummer, it will be very conſpicuous in exceeding ſharp weather; though men's arms, at leaſt the external parts of them, ſeem to have leſs heat in froſty weather, than in ſummer; ſince in the former of thoſe ſeaſons, they are wont to be manifeſtly more ſlender, the fleſhy parts and juices being condenſed by the coldneſs of the air. And though the inſenſible tranſpirations, that continually exhale from all the parts of our bodies, are not wont to be viſible here, even in winter; yet in extremely cold countries, as *Nova Zembla*, or *Charleton Iſland*, thoſe effluvia have been obſerved, not only to be thickened, but to be turned into ice itſelf, ſometimes within the ſeamen's ſhoes. And here in *England*, having not long ſince imployed a

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[*] *Hancque naturam, lacum ſimilem, prope metropolin Nidroſienſem regni Norvegiæ, habere compertum eſt, eo præcipue argumento, quod in mediis frigoribus nunquam congelatur.* Lib. 2.

[†] *Joſeph. Acoſt. Hiſt. Ind.* pag. 174.

labouring man to dig a deep hole in very froſty weather, two ſervants of mine, that ſtood by to ſee him work, did both of them aſſure me, when they returned, that the ſteams of his heated body were frozen upon the outſide of his waiſtcoat, which, one of them, whilſt the other was about to give me notice of it, inconſiderately wiped off.

43. AND ſince we ſee, how faſt the water in ponds and ditches waſtes and decreaſes in ſummer, there is no cauſe to doubt, but that it does then continually emit exhalations, as well, if not much more plentifully, than in winter: which may be manifeſtly confirmed by this, that in the ſummer one ſhall often ſee, in the mornings or evenings, the face of the water covered with a miſt or ſmoke, that riſes out of it. And I have ſometimes taken pleaſure to ſee this aggregate of exhalations hover over the water, and make, as it were, another river of a lighter liquor, that conformed itſelf, for a conſiderable way, to the breadth and windings of the ſtream, whence it proceeded. And I think it will be eaſily granted, that the water in ſummer-time is at leaſt as warm at noon, when ſuch exhalations are not viſible, as in the morning when they are, though the air be colder at this part of the day, than at that; which obſervation gives us the true reaſon of the phænomenon.

44. AND though, notwithſtanding all this, it were made to appear, that in ſome caſes, the ſmoking water of ſprings may be really warmer in winter than in ſummer; yet a ſufficient reaſon of the phænomenon may be fetched from what I have already delivered about the detention of the warm ſubterraneal vapours by the froſt, and ſnow, and rain, that make the earth leſs perſpirable in winter.

45. AND becauſe I know *Themiſtius* will look upon a thing ſo diſagreeable to the vulgar opinion, of the coldneſs of the whole element of earth, as a paradox; I will take this opportunity to add a further confirmation to what I have been ſaying.

46. AND firſt, that there ariſe copious and warm ſteams from the lower parts of the earth, may be proved, not only by what I have already mentioned, touching the Hungarian mines, but by the common complaint of diggers in moſt, though not in all deep mines, that they are oftentimes troubled, and ſometimes endangered by ſudden damps, which do frequently ſo ſtuff up and thicken the ſubterraneal air, that they make it not only unfit for reſpiration, but able to extinguiſh the lamps and candles, that the miners uſe, to give them light to work by. And I remember, that I have viſited mines, where having enquired of the diggers, whether thoſe hot exhalations, that compoſe their damps, did not ſometimes actually take fire within the bowels of the earth? I was anſwered, that in ſome of their pits (and particularly in one, that they ſhewed me) though not in all, they did; inſomuch that the exhalation ſuddenly kindling, would make a report at the mouth of the pit like a muſquet, or a ſmall piece of ordnance, and the flame would actually burn off the hair, and ſcorch the ſkins of thoſe workmen, that did not ſeaſonably get out of the pit, when the exhalation appeared to be near in aſcenſion, or did not nimbly fall down flat with their faces to the ground, till the flame was gone out. And one of theſe workmen, that I aſked, affirmed himſelf to have been ſeveral times, to his no ſmall trouble, ſo burned, and that (if I much miſremember not) twice in one day. And it ſeems to me as well as to *Morinus* very probable, that thoſe great quantities of rain and ſnow, and ſtorms, and (perhaps) ſome other meteors, that are taken notice of in winter, may rather conſiſt of theſe ſubterraneal ſteams, than the vapours and exhalations attracted by the ſun, (or at leaſt may as much conſiſt of the former, as the latter.) For his heat is then very languid, and acts upon the ground but during the day-time

which is very ſhort, (whereas thoſe meteors are generated indifferently at all hours of the day and night) and the ſky is oftentimes, for many days together, quite overcaſt with clouds, and the ſurface of the ground ſo conſtipated with froſt, that it will ſometimes freeze even in the ſun-ſhine: ſo that it is not near ſo likely, that the heat of the ſun, in the midſt of all theſe diſadvantages, ſhould be able to elevate ſo great a plenty of exhalations and vapours, as are requiſite to compoſe the rain, and ſnow, and ſtorms, that ſometimes laſt almoſt all the winter, as that they ſhould be ſupplied by ſubterraneal ſteams copiouſly ſent up from the heat, that continually reigns in the lower parts of the earth, and by traverſing the ſea, and at other vents, get up into the air.

47. To make out this, my formerly quoted French author (*P. m.* 136.) relates a very memorable thing, that was told him by the maſters of thoſe mines in *Hungary*, (which are at leaſt as deep as any that I remember I have ſeen or read of) namely, that the miners were able certainly to foretel ſooner than any other mortals, the tempeſts and ſudden mutations, that were to happen in the air. For when they perceived by the burning blue of their lights, and by other manifeſt ſigns, that they could eaſily take notice of in their grooves, that ſtore of the tempeſtuous damp (if I may ſo call it) was aſcending from the lower parts of the earth, though the ſky above were clear, and the air calm; yet they could aſſuredly foretel the approach of a ſtorm, or ſome other great alteration in the air, which would accordingly enſue within no very long time after. And to confirm this narrative, I ſhall add, not only that it is agreeable to what I lately told you was affirmed to me by other mine-men, but that having enquired of a very ingenious phyſician, who lived many years in *Cornwall*, (a country you know famous for tin-mines, ſome of which are infamous for the damps that infeſt them) he told me, that divers of the experienced fiſhermen aſſured him, that oftentimes they did perceive fiſhes ſhining in the night, ſometimes in one place, ſometimes in another, which was ſuppoſed to be kindled by the ſulphureous and other ſubterraneous exhalations; and that, when they perceived thoſe fires (eſpecially if any number appeared in ſeveral places) thoſe, that were well acquainted with the coaſt, would not continue long out at ſea, but rather quit an opportunity of catching fiſh, than not make ſeaſonably to the ſhore; having often obſerved, and particularly this laſt year, that bold and unexperienced mariners, by ſlighting theſe fore-runners of ſtorms, were in few hours ſhipwrecked by them.

48. To this I ſhall add, what happened ſome years ſince, upon the Iriſh coaſt, near a ſtrong fortreſs, called *Duncannon*, where divers of the ſhips royal of *England* lying at anchor, in a place where they apprehended no danger from the wind, there ſeemed ſuddenly to aſcend out of the water, not far from them, a black cloud, in ſhape and bigneſs not much unlike a barrel; which mounting upwards, was not long after followed, as the moſt experienced pilot foretold, with ſo hideous a ſtorm, as forced thoſe ſhips to go to ſea again, and had like to have caſt them away in it. And this account was both written by the principal officers of the ſquadron to their ſuperiours in *England*, and given, ſoon after it happened, by the chief of thoſe eye-witneſſes (and particularly by the pilot) to a very near kinſman of mine (well verſed in maritime affairs) that commanded the land-forces in thoſe parts, as a truth no leſs known than memorable.

49. AND on occaſion of what I was ſaying, about the eruption of hot ſteams, in ſeveral parts of the earth, I now call to mind ſomething, that I have met with in a very ſmall, but curious diſſertation, *De admirandis Hungariæ aquis*; whoſe anonymous author I gather, from ſome paſſages in the tract itſelf, to have been a nobleman, governour of *Saros*, and ſome other places in *Hungary*, and to have written this

diſcourſe, both for, and to that inquiſitive German Baron, *Sigiſmundus Liber*, famous for the account he gave the world of the embaſſy, whereon he was ſent by the German to the Ruſſian emperor. This anonymous, but noble writer, tells us then, that in that part of *Hungary*, which he calls * *Comitatus Zolienſis*, there is a gaping piece of ground, which does emit ſuch mortal expirations, that they ſuffocate, not only cats and dogs, purpoſely held at the end of long poles over the cleft, but kill even birds, that attempt to fly over it. And in other places of the ſame tract, I have met with many other relations, which if I had time to make a particular mention of, would much countenance what I have been lately ſaying: but though I pretermit ſeveral other inſtances, I cannot but take eſpecial notice of one, which (together with what I lately mentioned to have happened near *Duncannon*) may make it probable, that not only under the ſurface of the dry ground, but in that part of the terreſtrial globe, that is covered with water, there may ariſe ſteams, (and conſequently exhalations) actually, and that conſiderably hot. For in one † place he takes notice, that, not far from the well-known city of *Buda*, there is a hot ſpring (which they call Purgatory) which the waters of *Danubius* itſelf are not able to keep from being hot: nay, within the very banks, betwixt which that great river runs, there boil up hot ſprings, where thoſe, that will go deep enough into the water, may commodiouſly bathe themſelves. And ‡ elſewhere ſpeaking of the river *Iſtroganum*, in the ſame country, he adds, that not only the banks of it, but within the very river itſelf, one may diſcover hot ſprings, by removing the ſand at the bottom with one's feet. To this I ſhall add, that having heard of a ditch in the North of *England* (in ſome regards more ſtrange, though leſs famous than the ſulphureous grotto near *Naples*) whence not only ſubterraneal ſteams, but thoſe ſo ſulphureous, as to be eaſily inflammable, did conſtantly and plentifully aſcend into the air, I had the curioſity to make enquiry about it, of the miniſter of the place, (a very learned man, and converſant in mines) who then happened to be my neighbour, and he atteſted the truth of the relation upon his own knowledge. And it was confirmed to me by a very ingenious gentleman, who went purpoſely to viſit this place, and found it true, that a lighted candle, or ſome ſuch actual burning body being held, where this exhalation iſſued out of the earth, would kindle it, and make it actually flame for a good while, and (if I miſremember not) as long as one pleaſed. And as this place was but a few years ſince taken notice of, ſo there may be probably very many others, yet undiſcovered, that may ſupply the air with ſtore of mineral exhalations, proper to generate fiery meteors and winds. I remember, that having lately aſked an inquiſitive gentleman, that is a great ſearcher after mines, whether he did not obſerve ſome meteors near thoſe places, where he is moſt converſant? he told me, that it is very uſual in ſome of them, to ſee certain great fires moving in the air, which in thoſe places, diggers, becauſe of ſome reſemblance (real or imaginary) are wont to call dragons. [And the Ruſſian emperor's phyſician, you were ſpeaking of, informed me a while ſince, that he had, not long ago, obſerved in winter a river in *Muſcovy*, where, though the reſt of the ſurface was frozen, there was a part of it near a mile long, that remained uncovered with ice, which probably was kept from being generated there by thoſe ſubterraneous exhalations, ſince he ſays he ſaw then aſcend up all the way like the ſmoke of an oven.] And in caſe the matter of fact delivered by *Olaus Magnus* * be true, concerning the ſtrange thaws, that ſometimes happen, with terrible noiſes in the great lake *Veter*, thoſe wonderful phænomena may not improbably be aſcribed to the aſcent of great ſtore of hot ſubterraneal ſteams, which ſuddenly cracking thick and ſolid ice in many places at once, produce the hideous noiſes, and the haſty thaw, that he ſpeaks of. And this ſuſpicion may be countenanced partly by this circumſtance, that before theſe ſudden thaws, the lake begins with great noiſe to boil at the bottom; and partly by what is related by a more authentick writer, I mean that learned traveller the Jeſuit *Martinius*, who witneſſes, that at *Peking*, the royal city of *China*, it is very uſual, that after the rivers and ponds have continued hard frozen over, during the winter, the thaw is made in one day; which, ſince the freezing of the waters (as he tells us) required many, makes it very probable, that the ſudden thaw is effected (as he alſo inclines to think) by ſubterraneal ſteams, which I may well ſuppoſe to be exceeding copious, and to diffuſe themſelves every way to a very great extent, ſince they are able ſo ſoon to thaw the rivers and ponds of a large territory, and that (which makes mainly for my preſent purpoſe) beginning contrary to vulgar thaws, from the bottom upwards.

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* *Qui vero in comitatem Zolienſem, dum aquas perſequimur, ventum eſt, non poſſum præterire hiatum terræ iiſdem in locis famoſum ob peſtilentes expirationes, quibus aves ſuper-volantes, & quævis alia animantia extingui conſtat, manifeſto eorum experimento, qui,* &c. Pag. 74.

† *Ibidem eſt ſub dio fons calidarum cæteris amplior, quem Purgatorium vocavere, ea nimirum ratione, quod, quemadmodum proditum eſt in purgatorio pœnas nocentium pro noxarum modo, alias acerbiores, alias mitiores, ita quædam inſunt aquæ hoc in fonte diſcrimina, nam quâ in eum à Danubii ripâ aditus eſt, ſubfrigida primum, mox tepida, & quo in eum penetraris altius hoc magis calet. In receſſu vero interiore tam eſt calida, ut ferri non poſſit. Eſt etiam is calor haud dubie aquæ hujus proprius; nam alia, quæ dixi, temperamenta veriſimile eſt à Danubio accedere, qui crepidinem hujus fontis lambit, & cum vel modicè excreſcit, totum inundat, neque tamen ita reſtinguit, quin caleat. Quin intra ipſam ripam, qua Danubio perennis curſus eſt calidæ ebulliunt, ubi qui altius mergi volunt lavare conſueverunt.* Pag. 57.

‡ *Neque in ripâ tantum eruuntur Calidæ, ſed etiam intra amnem, ſi fundum ejus pedibus ſuffodias. Calet aut immodicè, nec ſunt idoneæ balneis, niſi temperentur, quod admiſtione frigidæ de proximo hauſtæ in proclivi eſt.* Pag. 65.

50. AND having thus manifeſted, that the lower parts of the earth do ſend up great ſtore of exhalations and vapours to the upper parts, it will be obvious to conceive, that as in divers places of the terreſtrial globe, theſe ſteams get into the air, either by the advantage of finding vents, ſuch as thoſe I have already mentioned, or by growing copious enough to force themſelves a paſſage; ſo in moſt other places, where the aſcending ſteams find no commodious vents, or are too faintly driven up to gain themſelves a paſſage, they muſt be repreſſed or detained beneath the ſurface of the earth, which has its pores in winter uſually choaked up with ſnow or rain, or its ſurface conſtipated and hardned with ice or froſt: ſo, that theſe exhalations being pent up, and receiving freſh ſupplies, from time to time, from beneath, it were no wonder, if they ſhould ſomewhat warm deep cellars and wells, where they are thus detained; and therefore our huſbandmen do not ſpeak altogether ſo improperly, when they ſay, that the ſnow keeps the ground warm. And I remember, that Dr. *Smith*, the learned Engliſh Ambaſſador into *Moſcow*, makes it to be one of the principal reaſons of the great fertility, he juſtly aſcribes to the country thereabout, that during almoſt all the winter, the ground is to a great height covered with ſnow; which does not only inrich it by the fertilizing ſalt, which the earth gains from the ſnow, when that comes to be melted, but does alſo contribute to its improvement, by choaking up, or obſtructing the pores, at which the nitro-ſulphureous, and other uſeful corpuſcles, that are ſent up by the ſubterraneal heat, would eaſily get away. And leſt, Gentlemen, you

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* *Nec prætereundum hic puto Lacum eſſe* LX. *milliarum in longitudine,* & XX. *in latitudine Italicorum,* Veter *appellatum, in Regno Oſtrogothorum, quæ talis eſt naturæ, quod cum tempeſtuoſo vento congelatus fuerit,* & *tempus reſolutionis immineat, vehementiſſimo ſtrepitu incipit fundo ebullire* & *commoveri, magna violentia perrumpere in parvas rimas, vel ſciſſuras, quæ fiunt in glacie,* & *has in modico temporis ſpatio faciens valdè latas, licet pro tunc glacies in ſpiſſitudine habuerit, pluſquam unum, vel duo brachia.* Lib. primo, pag. 23.

ſhould think, that it is only by the ratiocination, that I conclude, that there is really great ſtore of warm ſteams detained under ground in the winter; I ſhall add this ſenſible obſervation, received from the Ruſſian emperor's phyſician already often mentioned, by whom I have been aſſured, that about *Muſcow*, where the ſurface of the ground is far more conſtipated in winter, than it is in theſe parts, and where they are wont to keep their cellars much cloſer, the ſubterraneous exhalations being hindered to fly abroad, will in time multiply ſo faſt, that he aſſures me, that upon the unwary opening of the doors of cellars, that have been long kept ſhut, there would ſally out a warm ſmoke, and very thick, almoſt like that of a furnace, and ſometimes the ſteam, that iſſues out, will be ſo groſs and plentiful, that it has brought men into danger of being ſuffocated by it.

51. AND now, gentlemen, having ſhewn, that though experience be ſo confidently appealed to by the maintainers of Antiperiſtaſis, yet ſhe has not hitherto afforded them any thing, that much favours their cauſe; it remains, that I ſhew, that ſhe bears witneſs againſt it. For beſides that ſome paſſages of my late diſcourſes do really contain phænomena, that not only do not favour Antiperiſtaſis, but may juſtly be imployed as experiments againſt it, I ſhall *ex abundanti* (as they ſpeak) preſent you with ſomething, which I neceſſitated experience to ſupply me with, that ſeems expreſly to overthrow it.

52. I MIGHT urge againſt thoſe, who, though they begin to be aſhamed of the doctrine of the ſchools, would eſtabliſh an Antiperiſtaſis upon the account of what they call a *fuga contrarii*, that the very inſtance they are wont to bring for their opinion, may be retorted upon them. For when they tell us, that in winter, the heat, to fly the cold of the external air, retires itſelf into the lower parts of the earth, and there harbours in cellars and wells, as may be proved by the ſmoking of water drawn from deep wells, which argues its heat, the vapours, which fly away, being, as vapours hot in compariſon of the outward air; we may eaſily anſwer, by demanding, why, if the heat, that was harboured in a ſmoking bucket of water, have the wit or inſtinct to fly from its contrary, it does not in the bucket, as it is ſaid to do in the well, retire itſelf as far as it can from the ſurrounding cold of the ambient air; but inſtead of retiring to the innermoſt parts of the water (thoſe being remoteſt from that) it needleſly flies abroad, with the vapours it excites, and does, as it were, of its own accord caſt it ſelf into the arms of the enemies it ſhould ſhun. And indeed what I juſt now mentioned to you, as related to me by Dr. *Sam. Collins*, the great duke of *Muſcovy*'s phyſician, does ſufficiently manifeſt, that the cauſe, why the corpuſcles, that keep cellars warm, abide beneath the ſurface of the earth in winter, is not that they fly the cold as their enemy, but that they are pent up beneath the ground; ſince, when vent is given them, they immediately ruſh into the open air, without fearing the cold even of *Ruſſia* in the very midſt of winter.

53. BUT I ſhall preſs this no further, but rather add, that the doctrine of Antiperiſtaſis is as little beholden to the following experiment, which I ſometimes tried, in order to the diſabuſing ſome abetters of *Themiſtius*. I took then an iron-rod, of about the bigneſs of a man's finger, having at one end of it a very broad and thick piece of iron (ſhaped almoſt like a ſpattule) that the quantity of the matter might, upon the ignition of the iron, make the heat very conſiderable: then having cauſed this thick end to be made red-hot in the fire, and having ſuddenly quenched it in cold water, I could not perceive, that the other end of the rod, by which it was wont to be held, did at all grow ſenſibly hot, as a favourer of Antiperiſtaſis would have expected it ſhould do to a very high degree, as preſuming, that the innumerable particles of heat, that ſwarmed in the compact body of the red-hot part of the iron, muſt, to fly the

cold of the water, retire in throngs towards the other extreme of the iron, and make it exceedingly hot. And leſt any pre-exiſtent warmth ſhould hinder me from perceiving an increaſe of heat, in caſe any were produced in the handle of the iron, I cauſed it the next time the trial was made, to be kept in cold water; and yet even then, the immerſion of the broad and candent end into the cold water brought as little of ſenſible heat to the other end, that I held in my hand, as it had done the time before; and having cauſed the experiment to be tried by another, the account I received was, that it ſucceeded with him, as it had done with me.

54. BUT this is not the main thing, gentlemen, that I intend to acquaint you with, there being an expedient, that I purpoſely deviſed to make one experiment, more conſiderable againſt Antiperiſtaſis, than are in ſeveral miſtaken obſervations of the Peripateticks to eſtabliſh it.

55. I TOOK then a good ſealed weather-glaſs, twelve or fourteen inches long, furniſhed with good ſpirit of wine, and having provided an open-mouthed glaſs of a convenient ſhape and ſize, and filled it but to a due height (that it might not afterwards run over) with common water, I ſo ordered the matter, that the ſtem of the thermoſcope being ſupported by the cork, into which by a perforation or ſlit it was inſerted, when the glaſs was ſtopped by the cork, the whole ball of the thermometer was immerſed in the water, that filled the wide-mouthed glaſs, and did no where touch either the bottom or the ſides of the glaſs, ſo that the ball or bubble was every way ſurrounded with water. The inſtrument being thus prepared, we obſerved at what ſtation the ambient cold water had made the tincted ſpirit reſt in the ſtem of the thermoſcope; and then having provided a fit proportion of warm water in a commodiouſly ſhaped veſſel, I removed the inſtrument into it, and placed it ſo, as that the external warm water reached to a convenient height on the outſide of the open-mouthed glaſs: but though I carefully watched, whether the heat of the external water would increaſe or ſtrike inwards the cold of that water, which did immediately incompaſs the ball of the weather-glaſs; yet I perceived no ſuch matter, the tincted ſpirit in the ſtem keeping its ſtation (without ſinking beneath it) till the heat, after a while, having by degrees been diffuſed through the formerly cold water, by the intervention of that now warmed, the tincted ſpirits in the thermometer began to aſcend.

56. AND to reduce the other part too of the doctrine of Antiperiſtaſis, to the determination of an experiment, the ſame thermoſcope was placed in the ſame wide-mouthed glaſs juſt after the former manner; only inſtead of the cold water, that, which immediately ſurrounded the glaſs, was warm; and when the warmth had impelled up the tincted ſpirit, till its aſcent began to be very ſlow, I immerſed the inſtrument to a convenient depth in a veſſel, that contained highly refrigerated water, mingled with divers pieces of ice. But notwithſtanding my watchfulneſs, it did not appear to me, that the water, that did immediately encompaſs the ball of the weather-glaſs, was at all increaſed or intended, by that liquor's being beſieged by water exceeding cold; for the languid motion of the tincted ſpirit upwards was not hereby ſo much as ſenſibly accelerated, (as it muſt have been conſiderably, if the heat of the internal water had been ſo augmented, or ſtruck inwards by the cold of the external, as the ſchools doctrine would have made one expect) but rather the aſcent was, by the chillingneſs of the contiguous water, quickly checked, and the formerly aſcending ſpirit was ſoon brought to ſubſide again. And to give myſelf the fuller ſatisfaction about ſome of the chief phænomena of this, and the former experiment, I had the curioſity to obſerve them more than once.

# POSTSCRIPT.

## *A ſceptical Conſideration of the heat of cellars in winter, and their coldneſs in ſummer.*

THE foregoing diſcourſes of *Carneades* ſeem to have ſufficiently ſhaken the foundations of the vulgar doctrine of Antiperiſtaſis, ſo far forth as it is ſuperſtructed upon the vulgar obſervations and phænomena, whereon men are wont to build it; and it ſeems to have made it alſo highly probable, that in caſe ſome of the examples wont to be produced in favour of Antiperiſtaſis ſhould prove hiſtorically true, yet thoſe phænomena may, more congruouſly to the wonted proceedings of nature, be explicated by the detention of calorifick or frigorifick corpuſcles, by the operation of the external cold or heat, than to a certain inexplicable ſelf-invigoration, which is commonly propoſed in ſuch a way, as inveſts inanimate bodies with the prerogatives of free agents. But though *Carneades* his adverſaries ſeem not to have well made out the hiſtorical part of the received doctrine concerning cold; yet upon an impartial ſurvey of what has been alledged on both ſides, I freely confeſs, that to me ſome of the matters of fact themſelves ſeem not yet ſo clearly determined as I could wiſh: for as to the obvious phænomena, that nature does, as it were, of her own accord preſent us, they ſeem to have been but perfunctorily conſidered, and our ſenſes only being the judges of them, we may eaſily, as *Carneades* argues, be impoſed upon by the unheeded prediſpoſitions of our organs. And as for contrived and artificial experiments, there ſcarce ſeem to have been any made fit to clear the difficulties, that invite me to ſuſpend my judgment, as to the grand queſtion (or fact) whether cellars, and other ſubterraneous places, be really hotter in winter than in ſummer.

It is true, that I have ſcarce met with any point, wherein the modern ſchoolmen ſeem to have ſo much conſulted nature, as in this of Antiperiſtaſis. For enquiring what has been written of that ſubject, that may either confirm or oppoſe what has in the precedent dialogue been delivered about Antiperiſtaſis; I found, that the curiouſneſs and importance of the ſubject have made two or three of thoſe writers leſs negligent than I ſuſpected. But though I have lately met with in them an experiment or two, that ſeem cogently to evince, I do not ſay an Antiperiſtaſis in the ſenſe of the ſchools, but that ſubterraneal places are really hotter in winter than in ſummer, yet I muſt for a while longer continue my ſuſpenſion of judgment, which that even ſuch perſons, as are circumſpect themſelves, may not think unreaſonable, I will briefly ſubjoin the grounds of my ſcepticiſm about this matter.

First then, the learned Jeſuit *Zucchius*, who is wont to be far more induſtrious than other Ariſtotelians (and on ſome ſubjects is careful to propoſe experiments, though he be not ſo clear and happy in expreſſing his thoughts) aſſures us ſomewhere, that having kept a good ſealed weather-glaſs, for three years together, in a good cellar, he found the water to riſe by the coldneſs of the ambient air in the ſummer, and to be depreſſed by the rarefaction of it in the winter; which ſeems undeniably to infer, that whatever be the reaſon of it, the heat in ſubterraneal places is indeed greater in winter than in ſummer. And another recent ſchoolman, who, as I am told, is of the ſame order, though the learned man publiſhed his little book under one of his diſciple's names, affirms, that he found by a weather-glaſs, that a well at the place, where he lived, was colder in ſummer, and hotter in winter. And theſe aſſertions of ***Zucchius***, and the other Jeſuit, do, I confeſs, reſtrain me for a while from yielding a full aſſent to what *Carneades* hath delivered, as to the matter of ſubterraneal cold and heat. But on the other ſide, I am not hitherto reduced by theſe experiments, to declare with his adverſaries againſt him, becauſe of the following ſcruples.

First then I conſider, that it is not univerſally true, which is wont to be indefinitely affirmed, and believed, that cellars and other ſubterraneal places are hotter in winter than in ſummer. For the inſtances produced by *Carneades* ſeem plainly enough to manifeſt the contrary, and my own obſervations made in a cellar with a ſealed weather-glaſs do keep me from diſſenting from *Carneades* as to that point. I would therefore make a diſtinction of ſubterraneal places; for ſome are deep, as the beſt ſort of cellars; others deeper yet, as the Hungarian mines, mentioned by *Carneades* out of *Morinus*; and ſome again are but ſhallow, as many ordinary cellars and vaults: of theſe three ſorts of ſubterraneal places, the deepeſt of all do not, as far as the authority of mineraliſts above alledged may be relied on (for I am yet inquiring further) grow hot and cold according to the ſeveral ſeaſons of the year, as the vulgar doctrine of Antiperiſtaſis requires, but are continually hot: the ſhallower ſort of ſubterraneal places, though by reaſon of their being fenced from the outward air, they are not ſo ſubject to the alterations of it, whether to heat or cold, as open places are; yet by reaſon of their vicinity to the ſurface of the earth, they are ſo far affected with the mutations, which the outward air is liable to in ſeveral ſeaſons of the year, that in winter, though they be warm in reſpect of the colder air abroad, yet they are really (at leaſt ſome of them) as far as I have tried, colder in very cold weather, and leſs cold in warm weather. And in this opinion I am confirmed by two things; the one, that having purpoſely inquired of the *Polonian* nobleman mentioned by *Carneades*, whether he had obſerved in his country, in ſharp winters ſmall beer would freeze in cellars, that were not very deep, but would continue fluid in thoſe that were, he aſſured me he had taken notice of it: The other thing is the confeſſion of the anonymous Jeſuit lately mentioned, who acknowledges, that he found but little difference between the temperature of the water in the well he examined in ſummer and in winter, though it were a conſiderably deep one; and adds a while after, that at *Florence*, where the ſubterraneal vaults are ſhallower, the air is obſerved to be colder in winter than in ſummer, though at *Rome*, in their deep cellars, the contrary has been found. So that the lowermoſt ſort of ſubterraneal cavities being, for aught appears, perpetually hot, and the upper or ſhallower ſort of them being colder, not hotter in cold weather than it is in warm, it is about the temperature of the middle ſorts of them, ſuch as are the deeper and better cellars, that the queſtion remains to be determined. And thus much of my firſt conſideration.

The next thing I ſhall offer to be conſidered is this; that it is not ſo eaſy a matter, as even philoſophers and mathematicians may think it, to make with the weather-glaſſes hitherto in uſe, an experiment to our preſent purpoſe, that ſhall not be liable to ſome exception, eſpecially if the cellars or wells, where the obſervations are to be made, be very deep. For the gravity of that thick and vapid ſubterraneal air, and the greater preſſure, which the air may there have, by reaſon of its preſſing, according to an atmoſpherical pillar lengthened by the depth of the cellar or well, may, in very deep cavities, as well alter the height of the water in common weather-glaſſes, as heat and cold do, and ſo make it uncertain, when the mutation is to be aſcribed to the one, and when to the other; or at leaſt very difficult to determine diſtinctly, what ſhare is due to the preſſure, and what to the temperature of the air. And this uncertainty may be much increaſed by this more important conſideration, that not only in places, where the heights of the atmoſpherical cylinders are differing, the preſſures of the air upon the ſtagnant water in the weather-glaſſes may be ſo too, but even in the ſelf-ſame place, the inſtrument remaining unmoved, the preſſure of the atmoſphere may, as I have often obſerved, haſtily and conſiderably alter, and that without any conſtant and manifeſt cauſe (at leaſt that I could hitherto diſcover) ſo that the erroneous eſtimate, that may be hereby ſuggeſted of the temperature of the air, can ſcarce poſſibly be avoided, without the help of a ſealed weather-glaſs, where the included liquor is ſubject to be wrought upon by the heat and cold, not preſſure of the air. So that to apply this to *Zucchius* his experiment, unleſs he had been aware of this, and unleſs I knew, that he had divers times made his obſervations, with the aſſiſtance of a ſealed weather-glaſs, it may be ſuſpected, that he might accidentally find the water in his common weather-glaſs (for ſuch a one it appears he uſed, as probably knowing no other) to be higher, when he looked on it in ſummer, than when he looked on it in winter, not becauſe really the ſubterraneal air was colder in the former ſeaſon, than in the latter, but becauſe the atmoſphere chanced then to be heavier. And when I remember, in how few hours I have ſometimes, and that not long ſince, obſerved the quickſilver, both in a good barometer, and even in an unſealed weather-glaſs furniſhed with quickſilver, to riſe almoſt an inch perpendicularly, without any manifeſt cauſe proceeding from cold; I cannot think it impoſſible, that in long weather-glaſſes furniſhed only with water, or ſome ſuch liquor, the undiſcerned alterations of the atmoſphere's preſſure, may produce very notable ones in the height of the water in ſuch inſtruments. But this is not all, that a jealous man might ſuſpect. For *Zucchius* having, for aught appears, made his obſervations but in one place, we are not ſure, but that may be one of thoſe, whereof there may be many, on which ſubterraneal exhalations have a peculiar, and not languid influence; as *Carneades* has towards the cloſe of his diſcourſe made probable, out of the relations of *Olaus Magnus*, and *Martinius*, touching the great and ſudden thaws, that ſometimes begin from the bottom, and thereby argue their being produced by copious ſteams, that aſcend from the lower parts of the terreſtrial globe; which may be further confirmed by what he formerly noted of the ſudden damps, that happen in many mines. But that, which is of the moſt importance about our preſent inquiry, remains yet to be mentioned; which is, that having had the curioſity to inquire, whether no body elſe had made experiments of the ſame kind; I find, that the learned *Maignan* had the ſame curioſity, that *Zucchius* had, but with very differing ſucceſs; and therefore, though this inquiſitive perſon do admit, in his diſputation about Antiperiſtaſis, a notion, that I confeſs I cannot approve, (ſince to aſcribe, as he does, a *fuga contrarii* * to cold and hot ſpirits, is, in my apprehenſion, to turn inanimate bodies

See the ſecond preliminary diſcourſe, that accompanies the Hiſtory of Cold.

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* My backwardneſs to admit a *fuga contrarii* may be ſomewhat confirmed by what I lately learned from the Engliſh extraordinary ambaſſador (the earl of *Carliſle)* into *Ruſſia*, newly returned thence. For meeting the other day with an opportunity of aſking his lordſhip a few queſtions (which he was pleaſed to anſwer with his wonted civility) about the cold in *Muſcovy*; I was informed by one of his anſwers, that his excellency had there the curioſity to obſerve ſome bottles of choice and ſtrong wine, that were vehemently frozen, and the opportunity to take notice, that the liquor was quite congealed throughout, and turned into ſolid ice: whence he rationally inferred, that the ſpirituous parts of wine did not in theſe bottles (for aught he acknowledged, that in greater veſſels, that may ſometimes hold true, which is ſaid of the production of ſpirit of wine by congelation) retire to the centre, and remain there unfrozen. And his lordſhip ingeniouſly purſued the experiment and confirmed the conjecture, by cauſing the ice to be taken out of the broken bottles, to be thawed by degrees into ſeveral veſſels, by which means he found, that the liquor afforded by the exterior parts of the reſolved ice was very little, if a leſs ſtrong, than that, which was obtained from the internal parts of the ſame ice. From which obſervation *Carneades* would argue, that at leaſt it is not univerſal, but in particular caſes, and therefore probably by accident, or upon particular accounts, that the concentration of the ſpirits of liquors is conſequent upon being expoſed to cold.

into intelligent and deſigning beings) yet he does juſtly and rationally reject, with *Carneades*, the vulgar doctrine of Antiperiſtaſis, and confirms his rejection of it by two experiments. For firſt, he ſays, that he found with a thermometer, that when in winter a cold northerly wind froze the water without doors, it was no leſs cold in wine-cellars, than it was at the ſame ſeaſon, and at the ſame hour of the day in his ſtudy, only the paper-ſhuts of his window, that regarded likewiſe the North, being put to. And though, if he had ſaid nothing elſe, I ſhould have ſuſpected, that this might have proceeded from the ſhallowneſs of the cellars he made his trial in; yet he prevents that ſuſpicion, by taking notice in one clauſe of his relation, that the cellars were of the very beſt of their kind, in which in ſummer the greateſt cold was wont to be felt. But his next experiment is yet more conſiderable, which I ſhall therefore deliver in his own words that follow: *Expertus ego ſum* (ſays he) *thermometro fideliſſimo, & à præcedente hyeme in ſequentem æſtatem prorſus invariato, inſtructo etiam tali aquâ, nempe in hoc ipſum ex præſcripto Trebellii, ita comparata, ut non exhaletur, neque minuatur; expertus (inquam) ſum in ſupradictis optimis cellis vinariis maximum, quod ardentiſſima æſtate fuit, frigus non adæquaſſe illud, quod ibidem erat brumali tempore, ut dixi in ſuperiori experimento, ſiquidem in tubo vitrei thermometri quatuor circiter palmos longo, & in octo gradus graduumque minuta diviſo, æqua hyeme aſcendit ad gradus 7. cum ſemiſſe, æſtate autem vix gradum ſextum ſuperavit, cum tamen ad ſenſum multo magis vigeret frigus iſtud æſtivum.*

Thus far this learned, as well as reſolute author, who ſeeming, by the mathematical part of his *Perſpectiva Horaria*, to be an accurate and induſtrious maker of obſervations, we may oppoſe this newly-recited experiment to that of *Zucchius*, which it flatly contradicts: and therefore ſince the depth of the cellars is of great moment in experiments of this nature; ſince alſo the particular parts of the place or ſoil, where the cellars or other cavities happen to be, may, in ſome caſes, not be inconſiderable; and ſince laſtly, neither *Zucchius* or *Maignan* ſeem to have been aware of the differing weights of the atmoſphere, in the ſelf-ſame place, (as not having ſeen the XVIIIth of our *Phyſico-mechanical Experiments*, before which I never ſaw nor heard of any thing publiſhed, or otherwiſe written to that purpoſe) I hope I ſhall be excuſed, if I retain ſome ſcruples about the hiſtorical queſtion I have been conſidering, till the experiment have been carefully made, for a competent ſpace of time in ſeveral places, and that not with common weather-glaſſes (like thoſe uſed by my two learned authors) wherein the liquor may be made to riſe and fall by the differing gravities of the air, but with ſealed thermoſcopes, wherein the alterations may more ſafely be ſuppoſed to proceed only from its heat and cold.

And to conclude, ſince *Carneades* has ſpeciouſly enough anſwered the other obſervations, that are wont to be produced in favour of the Ariſtotelian Antiperiſtaſis, if *Maignan*'s relation be better warranted by future experiments, than that of *Zucchius*, it will very much disfavour the whole doctrine itſelf, which ſeeming to have been deviſed, but to give an account of the phænomena, to which it is wont to be applied, conſidering men will be but little invited to imbrace it, if the matter of fact be as little certain, as what is propoſed in the hypotheſis is intelligible.

# AN
# EXAMEN
# OF
# Mr. HOBBES's Doctrine touching COLD.

## ADVERTISEMENT.

THE author of the following diſcourſe intending it ſhould make a part of certain conſiderations upon the four famous hypotheſes, or opinions, of the Nature and Cauſe of Cold; which (conſiderations) he thought fit to reſerve for the latter end of the hiſtory of that quality, was invited to ſuppreſs it ever ſince the former part of the year, that preceded the laſt. And though this diſcourſe, (both for other reaſons, and becauſe he found it more ready and finiſhed, than ſome other papers, that belonged to the ſame part of the newly mentioned hiſtory) comes abroad unaccompanied; yet he judged it not amiſs, to intimate thus much, that the reader may be informed, upon what account Mr. *Hobbes*'s opinions come to be examined in an hiſtorical treatiſe; and may not wonder either to find, that divers paſſages of it are omitted, that are unfavourable enough to Mr. *Hobbes*'s doctrine, or to meet with in a diſcourſe poſtponed to the *Hiſtory of Cold* ſome experiments, that ſeem to argue it to have been written before they were caſt into the order, wherein they now appear. To this I have nothing to add, but that whereas through haſte the ſcheme referred to in the long citation out of Mr. *Hobbes*'s has not been added to the others, that belonged to this book, I am not much troubled at the omiſſion (as alſo that in other quotations the place is not always as well mentioned as the words) becauſe, that if any ſhall be found, that after having conſidered, what I urge againſt the (great, but imaginary) intereſt, Mr. *Hobbes* would aſcribe to winds (whether he explicate their cauſes rightly or not) in the production of leſſer degrees of cold, but (how improbably ſoever) of congelation itſelf, ſhall think the ſight of that ſcheme of any importance; this learned man's book, *De Corpore*, is in ſo many hands, that any reader ſhall deſire it, may very eaſily have an opportunity to conſult the ſcheme in the particularly cited place.

1. MR. *Hobbes*'s Theory concerning Cold does to me, I confeſs, appear ſo inconſiderately pitched upon, and ſo ſlightly made out, that I ſhould not think it merited, eſpecially in an hiſtorical treatiſe, a particular or ſerious examination, but that in propoſing it, he ſcruples not to talk to his readers of his demonſtrations; and the preference he is wont to give himſelf above the eminenteſt, as well of modern as of ancient writers, has had no ſmall effect upon many, who not knowing, how indulgent ſome writers are wont to be to the iſſues of their own brain, as ſuch, are apt to miſtake confidence for evidence, and may be modeſt enough to think, that their not diſcerning a clearneſs in his explications and reaſonings, is rather a fault of their underſtandings, than of his doctrine. Mr. *Hobbes* delivers his theory in the ſeven firſt articles of the 28th chapter of the fourth part of his elements. But

becauſe the whole diſcourſe is too long to be here tranſcribed, and becauſe in the 2d 3d, and 4th ſections, that, which he treats of, is the generation of winds, and, that which he handles in the 5th, is the notion of a hard body; we may ſafely leave out thoſe four ſections, eſpecially ſince, though there be in them divers things about the motion of the ſun, and other matters, that are more ſtrongly aſſerted than proved, yet his doctrine tending but to ſhew, how the winds are generated, though it were granted, would make but very little, if any thing at all, towards the evincing of his theory about cold.

2. AND that we may not be ſuſpected to injure his opinion or his arguments, we will, though the citation will be ſomewhat prolix, firſt recite them, as himſelf delivers them in thoſe three ſections, that treat immediately of cold, and then we will ſubjoin our animadverſions on them.

Artic. 6. 3. [THESE things, ſays he, being premiſed, I ſhall ſhew a poſſible cauſe, why there is greater cold near the poles of the earth, than further from them. The motion of the ſun between the tropicks, driving the air towards that part of the earth's ſuperficies, which is perpendicular under it, makes it ſpread itſelf every way; and the velocity of this expanſion of the air grows greater and greater, as the ſuperficies of the earth comes more and more to be ſtraitned; that is to ſay, as the circles, which are parallel to the equator, come to be leſs and leſs. Wherefore this expanſive motion of the air drives before it the parts of the air, which are in its way, continually towards the poles more and more ſtrongly, as its force comes to be more and more united, that is to ſay, as the circles, which are parallel to the equator, are leſs and leſs; that is, ſo much the more, by how much they are nearer to the poles of the earth. In thoſe places therefore, which are nearer to the poles, there is greater cold, than in thoſe, which are more remote from them. Now this expanſion of the air upon the ſuperficies of the earth from eaſt to weſt doth by reaſon of the ſun's perpetual acceſſion to the places, which are ſucceſſively under it, make it cold at the time of the ſun's riſing and ſetting: but as the ſun comes to be more and more perpendicular to thoſe cooled places, ſo by the heat, which is generated by the ſupervening ſimple motion of the ſun, that cold is again remitted, and can never be great, becauſe the action, by which it was generated, was not permanent. Wherefore I have rendered a poſſible cauſe of cold in thoſe places, that are near the pole, or where the obliquity of the ſun is great.

Artic. 7. 4. How water may be congealed by cold, may be explained in this manner. Let A (in the firſt figure) repreſent the ſun, and B the earth; A will therefore be much greater than B. Let E F be in the plain of the equinoctial, to which let G H I K and L C be parallel. Laſtly let C, and D, be the poles of the earth. The air therefore by its action in thoſe parallels will rake the ſuperficies of the earth, and that with a motion ſo much the ſtronger, by how much the parallel circles towards the poles grow leſs and leſs. From whence muſt ariſe a wind, which will force together the uppermoſt parts of the water, and withal raiſe them a little, weakening their endeavour towards the center of the earth. And from their endeavour towards the center of the earth, joined with the endeavour of the ſaid wind, the uppermoſt parts of the water will be preſſed together and coagulated; that is to ſay the top of the water will be ſkinned over and hardened, and ſo again the water next the top will be hardened in the ſame manner, till at length the ice be thick. And this ice being now compacted of little hard bodies, muſt alſo contain many particles of air received into it. As rivers and ſeas, ſo alſo in the like manner may the clouds be frozen. For when by the aſcending and deſcending of ſeveral clouds at the ſame time, the air intercepted between them is, by compreſſion, forced out, it rakes, and by little and little hardens them. And though thoſe ſmall drops (which uſually make clouds) be not yet united into greater bodies, yet the ſame wind will be made; and by it, as water is congealed into ice, ſo will vapours in the ſame manner be congealed into ſnow. From the ſame cauſe it is, that ice may be made by art, and that not far from the fire; for it is done by the mingling ſnow and ſalt together, and by burying in it a ſmall veſſel full of water. Now when the ſnow and ſalt (which have in them a great deal of air) are melting, the air, which is preſſed out every way in wind, rakes the ſides of the veſſel; and as the wind by its motion rakes the veſſel, ſo the veſſel by the ſame motion and action congeals the water within it.

5. We find by experience, that cold is always more remiſs in places, where it rains, and where the weather is cloudy (things being alike in all other reſpects) than where the air is clear. And this agreeth very well with what I ſaid before; for in clear weather the courſe of the wind, which (as I ſaid even now) raked the ſuperficies of the earth, as it is free from all interruption, ſo alſo it is very ſtrong. But when ſmall drops of water are either riſing or falling, that wind is repelled, broken and diſſipated by them; and the leſs the wind is, the leſs is the cold.

6. We find alſo by experience, that in deep wells the water freezeth not ſo much, as it doth upon the ſuperficies of the earth. For the wind, by which ice is made, entering into the earth (by reaſon of the laxity of its parts) more or leſs, loſeth ſome of its force, though not much. So that if the well be not deep, it will freeze; whereas if it be ſo deep, as that the wind, which cauſeth cold, cannot reach it, it will not freeze.

7. We find moreover by experience, that ice is lighter than water, the cauſe whereof is manifeſt from that, which I have already ſhown, namely, that the air is received in, and mingled with the particles of the water, whilſt it is congealing.

8. To examine now Mr. *Hobbes*'s theory concerning cold, we may in the firſt place take notice, that his very notion of cold is not ſo accurately, nor warily delivered. I will not here urge, that it may be well queſtioned, whether the tending outwards of the ſpirits and fluid parts of the bodies of animals do neceſſarily proceed from, and argue heat. Since in our pneumatical engine, when the air is withdrawn from about an included viper (to mention no other animals) there is a great intumeſcence, and conſequently a greater endeavour outwards of the fluid parts of the body, than we ſee made by any degree of heat of the ambient air, wont to be produced by the ſun. This, I ſay, I will not inſiſt on, but rather take notice, that though Mr. *Hobbes* tells us, that to cool, is to make the exterior parts of the body endeavour inwards; yet our experiments tell us, that when a very high degree of cold is introduced, not only into water, but into wine, and divers other partly aqueous liquors, there is a plain intumeſcence, and conſequently endeavour outwards of the parts of the refrigerated body. And certainly cold having an operation upon a great multitude and variety of bodies, as well as upon our ſenſories, he, that would give a ſatisfactory definition of it, muſt take into his conſideration divers other effects, beſides thoſe it produces on human bodies. And even in theſe, he will not eaſily prove, that in every caſe any ſuch endeavour inwards from the ambient ætherial ſubſtance, as his doctrine ſeems to ſuppoſe, is neceſſary to the perception of cold; ſince, as the mind perceives divers other qualities, by various motions in the nervous or membranous parts of the ſentient; ſo cold may be perceived, either by the decrement of the agitation of the parts of the object, in reference to thoſe of the ſenſory; or elſe by ſome differing impulſe of the ſenſitive parts occaſioned by ſome change made in the motion of the

blood or ſpirits, upon the deadening of that motion; or by the turbulent motion of thoſe excrementitious ſteams, that are wont, when the blood circulates as nimbly, and the pores are kept as open as before, to be diſſipated by inſenſible tranſpiration.

9. IT may afford ſome illuſtration to this matter to add, that having inquired of ſome hyſterical women, who complained to me of their diſtempers, whether they did not ſometimes find a very great coldneſs in ſome parts of their heads, eſpecially at the top, I was anſwered, that they did ſo; and one of them complained, that ſhe felt in the upper part of her head ſuch a coldneſs, as if ſome body were pouring cold water upon it. And having inquired of a couple of eminent phyſicians, of great practice, about this matter, they both aſſured me, that many of their hyſterical patients had made complaints to them of ſuch great coldneſs in the upper part of the head, and ſome alſo along the vertebras of the neck and back. And one of theſe experienced doctors added, that this happened to ſome of his patients, when they ſeemed to him and to themſelves to be otherwiſe hot. The noble * *Avicen* alſo ſomewhere takes notice, that the invenomed bitings of ſome kinds of ſerpents, (creatures too well known in the hot countries, where he lived) made thoſe, that were bitten by them, either become or think themſelves very cold. But that will perhaps ſeem more remarkable, which I ſhall further add, namely, that I know a nobleman, who followed the wars in ſeveral countries, and has ſignalized his valour in them; and yet though his ſtature be proportionate to his courage, yet when this perſon falls (as frequently he has done) in a fit of the ſtone, he feels an univerſal cold over his whole body, juſt like that, which begins the fit of an ague. And though he aſſures me, that the ſtones, that torment him, and which he uſually voids, are but very ſmall; yet whilſt the fit continues, which oftentimes laſt many hours, he does not only feel an extraordinary coldneſs, but which is more ſtrange, and which I particularly inquired after, cannot by clothes, or almoſt any other means, keep himſelf warm.

10. I ELSEWHERE take notice of ſome other obſervations, agreeable to theſe, by ſome of which we may be perſuaded, that there may be other ways, beſides thoſe already mentioned, of perceiving cold, though the outward parts of our bodies were not preſſed inwards. And whereas Mr. *Hobbes* infers that he, who would know the cauſe of cold, muſt find by what motion or motions the exterior parts of any body endeavour to retire inwards, that ſeems but an inconſiderable direction. For in compreſſions, that are made by ſurrounding bodies, there is produced an endeavour inward of the parts of the compreſt body, though no cold, but ſometimes rather heat be thereby generated. And I hope Mr. *Hobbes* will not object, that in this caſe the parts do not retire, but are thruſt inwards, ſince, according to him, no body at all can be moved, but by a body contiguous and moved. But what I have hitherto taken notice of, being chiefly deſigned to ſhew, that the notion of cold in general is not ſo obvious a thing to be rightly pitched upon, as many think, and that therefore it needs be no wonder, that it hath not been accurately and warily propoſed by Mr. *Hobbes*; I ſhall not any further proſecute that diſcourſe, but proceed to what remains. Next then, the cauſe he aſſigns, why a man can blow hot or cold with the ſame breath, is very queſtionable; partly, becauſe he ſuppoſes in part of the breath ſuch a ſimple motion, as he calls it, of the ſmall particles of the ſame breath, as he will not eaſily prove, and as † eminent aſtronomers and mathematicians have rejected; and

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* Quoted by *Paul Neworaatz. De Purpura*, cap. 12.

† Dr. *S. Ward*, (now the worthy biſhop of *Exeter*) and Dr. *Wallis*, the learned Savilian profeſſor of Geometry, *&c.*

partly, becauſe that without the ſuſpected ſuppoſition, I could (by putting together the conjectures of two learned writers, and what I have elſewhere added of my own) give a more probable account of the phænomenon, if I had not ſome ſcruples about the matter of fact itſelf: which laſt clauſe I add, becauſe, though I am not ſure, that further trials may not ſatisfy me, that the wind or breath, that is blown out at the middle of the compreſſed lips, has in it ſuch a real coldneſs, as men have generally aſcribed to it, yet hitherto ſome trials, that my jealouſy led me to make, incline me to ſuſpect, there may be a miſtake about this matter, and that in eſtimating the temper of the produced wind, our ſenſes may impoſe upon us. For having taken a very good and tender ſealed weather-glaſs, and blown upon it through a glaſs pipe (of about half a yard long) that was choſen ſlender, to be ſure, that my breath ſhould iſſue out in a ſmall ſtream; by this wind beating upon the ball of the weather-glaſs, I could not make the included ſpirit of wine ſubſide, but manifeſtly, though not much aſcend, though the wind, that I preſently blew through the ſame pipe, ſeemed ſenſibly cold, both to the hand of by-ſtanders, and to mine own, and yet mine was more than ordinarily cold. So that having no great encouragement to enter into a diſpute about the cauſe of a phænomenon, whoſe hiſtorical circumſtances are not yet ſufficiently known and cleared, I will now proceed to add, that whatever be the cauſe of the effect, there are divers things that make Mr. *Hobbes*'s hypotheſis of the cauſe of cold unfit to be acquieſced in. For we ſee, that the grand cauſe he aſſigns of cold and its effects, is wind, which, according to him, *is air moved in a conſiderable quantity, and that either forwards only, or in an undulating motion:* and he tells us too, that when the breath is more ſtrongly blown out of the mouth, then is the direct motion prevalent (over the ſimple motion) which, ſays he, makes us feel cold; for, ſays he, the direct motion of the breath or air is wind, and all wind cools or diminiſhes former heat. To which words in the very next line he ſubjoins, that not only great, but almoſt any ventilation, and ſtirring of the air doth refrigerate. But againſt this doctrine I have ſeveral things to object.

Chap. 28. Sect. 2. at the beginning.

11. For firſt, we ſee there are very hard froſts, not only continued, but oftentimes begun, when the air is calm and free from winds; and high and boiſterous ſoutherly winds are not here wont to be near ſo cold as far weaker winds, that blow from the North-eaſt.

12. Next, if Mr. *Hobbes* teach us, that it is the direct motion of the ſtream of breath, that is more ſtrongly blown out, that makes us feel cold, he is obliged to render a reaſon, why in an æolipile with a long neck, the ſtream, that iſſues out, though oftentimes far ſtronger than that, which is wont to be made by compreſſing the lips, at a pretty diſtance from the hole it iſſues out of, is not cold, but hot.

13. Thirdly, Mr. *Hobbes* elſewhere teaches, that when in our engine the pump has been long employed to exhauſt, as we ſay, the receiver, there muſt be a vehement wind produced in that receiver; and yet by one of our other experiments it appeared, that for all this in a good ſealed weather-glaſs placed there, before the included air begins to be, as we ſay, emptied, there appeared no ſign of any intenſe degree of cold produced by this ſuppoſed wind, ſo that either the wind is but imaginary, or elſe Mr. *Hobbes* aſcribes to winds, as ſuch, an infrigidating efficacy, that does not belong to them.

14. Fourthly, we find by experience, that in hard froſts water will freeze, not only though there be no wind ſtirring in the ambient air, but though the liquor be kept in a cloſe room, where, though the wind were high abroad, it could not get admittance; and ſome of our experiments, carefully made, have aſſured us, that

water ſealed up in one glaſs, and that glaſs kept ſuſpended in another glaſs carefully ſtopt, to keep out not only all wind, but all adventitious air, may nevertheleſs be not only much cooled, but turned into ice.

See the 6th Section of the Hiſtory of Cold.

15. FIFTHLY, We found by other experiments, that a frozen egg, though ſuſpended in, and perfectly ſurrounded with water, where no wind can come at it, will be every way cruſted over with ice; in which caſe there is no probability, that the ice ſhould be generated according to the way propoſed by Mr. *Hobbes*. For he will ſcarce prove, nor is there any likelihood, that a wind pierced the ſhell and cloſer coats of the egg to get into the contained liquors, and freeze them: and a more unlikely aſſertion it would be, to pretend, (as he, that maintains Mr. *Hobbes's* doctrine, muſt) that ſo very little air, if there be any, as is mingled with the juices of the egg, is, by the cold, which is not wont to expand air (nor water, till it be ready to make it freeze) turned into a wind ſubtile enough, freely to penetrate the ſhell and coats of the egg, and great enough to diffuſe itſelf every way, and turn on every ſide the neighbouring water into ice; and all this notwithſtanding, that not only it appeared not by bubbles breaking through the water, that there is any adventitious air, that comes out of the egg at all; but that alſo, ſuppoſing there were ſome ſuch contained in the egg, yet what ſhadow of reaſon is there to conceive, that the air which was ingaged in, and ſurrounded with the ſubſtances of the white, and the yolk of the egg, muſt needs be a wind, ſince, according to Mr. *Hobbes*, that requires a conſiderable motion of moſt of the parts of the moved air the ſame way, and, according to him alſo, a body cannot be put into motion, but by another body contiguous and moved.

16. SIXTHLY, Mr. *Hobbes* does indeed affirm, that all wind cools, but is ſo far from proving, that the higheſt degrees of cold muſt needs proceed from wind, that he does not well evince, that all winds refrigerate. Nor are we bound to believe it without proof, ſince wind being, according to him, but air moved in a conſiderable quantity, either in a direct or undulating motion, it does not appear, how motion ſhould, rather than reſt, make air grow cold. For though it be true, that uſually winds ſeem cold to us; yet, in the firſt place, it is not univerſally true, ſince ſome, that have travelled into hot countries, and particularly the learned [*] *Alpinus*, have complained, that the winds coming to them in the ſummer from more torrid regions have appeared to them almoſt like the ſteam that comes out at the open mouth of a heated oven. And if [†] *Marcus Polus Venetus* be to be credited, (for I mention his teſtimony but *ex abundanti*) the ſouthern winds near *Ormus* have been ſometimes ſo hot, as to deſtroy an army itſelf at once. And ſecondly, even when the wind does feel cold to us, it may oftentimes do ſo but by accident; for, as we elſewhere likewiſe teach, the ſteams, that iſſue out of our bodies being uſually warmer than the ambient air, (whence in great aſſemblies, even thoſe, that are not thronged, we find it exceeding hot, and I have ſeveral times obſerved a hot wind to come from thoſe throngs, and beat upon my face) and the more inward parts of our bodies themſelves being very

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[*] *Euri, auſtrique venti à meridie loca arenoſa ſummoque calore inflammata tranſeuntes, atque Ægyptum ſpirantes, tantum caloris æſtus, pulverumque & inflammatarum arenarum evehunt, ut ignitas fornacis flammas, nec non pulveribus obſcuriſſimas nubes eo aſportaſſe videatur.* And elſewhere: *Prima æſtatis parte calidiſſima inæqualiſſimaque ob vehementiſſimum meridionalium ventorum calorem,* &c. Proſper Alpinus *de Medicina Ægyptiorum.*

[†] From nine till noon, there blows a wind with ſuch extreme heat from the ſands, that it ſwallows up a man's breath, and ſtifleth him. The King of *Chermain* ſent an army of ſixteen hundred horſe, and five thouſand foot, againſt the Lord of *Ormus*, for not paying his tribute, which were all ſurpriſed and ſtifled with that wind. *Marcus Polus* in *Purchas's Pilgrims, lib.* III. *p. m.* 71.

much hotter than the ambient air, eſpecially that, which is not yet full of warm ſteams, the ſame cauſes, that turn air into a wind, put it into a motion, that both diſplaces the more neighbouring and more heated air, and alſo makes it pierce far deeper into the pores of the ſkin, whereby coming to be ſenſible to thoſe parts, that are ſomewhat more inward than the cuticula, and far more hot, the air turned into wind ſeems to us more cold, than the reſtagnant air (if I may ſo ſpeak) upon ſuch another account as that, upon which, if a man has one of his hands hot, and another not, the ſame body that will appear lukewarm to this, will appear cold to the other; becauſe, though the felt body be the ſame, yet the organs of feeling are differently diſpoſed. And to confirm this doctrine by an experiment, (which has ſucceeded often enough, and need not ſucceed always to ſerve our preſent purpoſe) we will add, that though air blown through a pair of bellows upon one's hand, when it is in a moderate temper, will ſeem very cold; yet, that the ambient air by being thus turned into wind, does indeed acquire a relative coldneſs, ſo as to ſeem cold to our ſenſes, but yet without acquiring ſuch a cold as is preſumed, may appear by this, that by blowing the ſame air with the ſame bellows upon weather-glaſſes, though made more than ordinarily long, and by an artiſt eminent at making them, we could not obſerve, that this wind's beating upon them did ſenſibly refrigerate either the air, or the liquor. Though it is not impoſſible, but that in ſome caſes the wind may cool even inanimate bodies, by driving away a parcel of ambient air, impregnated with exhalations leſs cold, than the air that compoſes the wind. But this is not much, if at all, more than would be effected, if, without a wind, ſome other body ſhould precipitate out of the air near the weather-glaſs, the warmer effluvia we have been mentioning; eſpecially if the precipitating body introduce in the room of the diſplaced particles, ſuch as may in a ſafe ſenſe be termed frigorifick.

See this difficulty more largely handled in the firſt preliminary diſcourſe.

17. SEVENTHLY, nor can we admit, without a favourable conſtruction, Mr. *Hobbes*'s way of expreſſing himſelf, where he ſays, as we have lately ſeen, that all wind cools or diminiſhes former heat. For if we take heat in the moſt common ſenſe, wherein the word is uſed, not only by other writers, but alſo by philoſophers, to make wind the adequate cauſe of cold, it muſt in many caſes do more than diminiſh former heat. For water, for inſtance, that is ready to freeze, is already actually cold in a high degree, and yet the wind (if Mr. *Hobbes* will needs have that to be the efficient of freezing) muſt make this not hot, but already very cold liquor, more cold yet, before it can turn into ice.

18. THESE things thus eſtabliſhed, it will not be difficult to diſpatch the remaining part of Mr. *Hobbes*'s theory of cold. For, to proceed to his ſixth ſection, we ſhall paſs by what a coſmographer would perhaps except againſt in his doctrine about the generation and motion of the wind upon the ſurface of the earth, and ſhall only take notice in the remaining part of that ſection of thus much: That the moſt of what Mr. *Hobbes* here ſhews us, is but, that there is an expanſion of the air, or a wind generated by the motion and action of the ſun; but why this wind thus generated muſt produce cold, I do not ſee, that he ſhews; nor does his affirming, that it moves towards the poles, help the matter. For beſides that we have ſhewn, that wind, as ſuch, is not ſufficient to produce far leſs degrees of cold, than thoſe, that are felt in many northern regions, there muſt be ſome other cauſe, than the motion of the air or ſteams driven away by the ſun, to make bodies, not in themſelves cold, (for ſo they were ſuppoſed not to be, when the ſun began to put them in motion) become vehemently cold in their paſſage. For Mr. *Hobbes* cannot, as other naturaliſts, derive the coldneſs of freezing winds from the cold ſteams they meet with, and carry along with them in their paſſage through cold regions; ſince then thoſe ſteams rather than the

wind would be the cauſe of that vehement coldneſs; and ſo it might juſtly be demanded, whence the coldneſs of theſe cold exhalations proceeds. Beſides that, it is very precarious and unconſonant to obſervation, to imagine ſuch a wind, as he talks of, to blow, whenever great froſts happen, ſince, as we noted before, very vehement glaciations may be obſerved, eſpecially in northern regions, when the air is calm, and free from winds.

19. THE account he gives in his ſeventh ſection of turning water into ice, is the moſt unſatisfactory I have ever yet met with; for a good part of that ſection is ſo written, as if he were afraid to be underſtood. But whereas he ſuppoſes, that by the endeavour of the wind to raiſe the parts of the water, joined with the endeavour of the parts of the water towards the center of the earth, the uppermoſt parts of the water will be preſt together, and coagulated, he ſays that which is very far from ſatisfactory. For, firſt, ice is often produced, where no wind can come to beat upon the uppermoſt parts of the water, and to raiſe them; and in veſſels hermetically ſealed, which exactly keep out air and wind, ice may be generated, as many of our experiments evince. And this alone were a ſufficient anſwer, ſince the whole explication is built upon the action of the wind. But this is not all we have to object; for not to urge, that he ſhould have proved, that the uppermoſt parts of the water muſt be raiſed in congelation, eſpecially ſince oil, and divers other liquors, are contracted by it; not to urge this, I ſay, what ſhew of probability is there, that by the bare endeavour of the wind, and the gravity of the ſuperficiate parts of the water, there ſhould be any ſuch forcible compreſſion made, as he is pleaſed to take for granted? And yet this itſelf is leſs improbable, than that ſuppoſing the uppermoſt parts of the water to be preſſed together, that preſſure is ſufficient to coagulate, as he ſpeaks, or rather congeal them into ice. So bold and unlikely an aſſertion ſhould at leaſt have been countenanced by ſome plauſible reaſon, or an example in ſome meaſure parallel. For I remember not any one inſtance, wherein any degree of compreſſion, that has been imployed, much leſs ſo ſlight a one as this muſt be, conſidering the cauſes, whence it is ſaid to proceed, can harden any liquor, into ice, or any other hard body. And in the experiment, we have elſewhere mentioned, of filling a pewter veſſel with water, and when it is exactly cloſed, compreſſing it by the knocks of a hammer, till the water be reduced to penetrate the very pewter, we found not that ſo violent a compreſſion did give the water the leaſt diſpoſition to turn a hard body. And as for the way Mr. *Hobbes* aſſigns of increaſing the thickneſs of ice, it is very difficult to conceive, how a cake of ice on the top of the water, being hard frozen to the ſides of the containing veſſel, and thereby ſevering betwixt the included water and the external air; the wind, that cannot come to touch the water, becauſe of the interpoſition of the hard and rigid ice, ſhould yet be able, ſometimes at the depth of nine or ten foot, or much further, to beat upon the ſubjacent water, and turn it into ice. And it is yet more difficult to conceive, how the wind muſt do all this, when, as was lately noted, the water doth freeze more and more downwards, to a great depth, in places where the wind cannot come to beat upon it at all. And as to what Mr. *Hobbes* further teaches, that the ice muſt contain many particles of air received into it, we have elſewhere occaſion to ſhow, how erroneouſly he diſcourſes about thoſe icy bubbles.

In the new experiments touching the ſpring of the air.

See the 9th Title of the Hiſtory of Cold.

20. THE reaſon he aſſigns of the freezing of water with ſnow and ſalt, does as little ſatisfy as the reſt of his theory of cold. For not to mention, that he affirms, without proving it, that ſnow and ſalt have in them a great deal of air; it is very precarious to aſſert, that this air muſt be preſt out every way in wind, which muſt rake the ſides of the veſſel: for it is ſtrange, that far more diligent obſervers than Mr. *Hobbes* ſhould

take no notice of any ſuch wind, if any ſuch wind there were. But this is yet leſs ſtrange than that which follows; namely, that this wind muſt ſo rake the ſides of the veſſel, as to make the veſſel, by the ſame motion and action, congeal the water within it: for what affinity is there between a wind paſſing along the outſide of a glaſs, altogether impervious to it, and the turning a fluid body, included in that glaſs, into a hard and brittle body? The wind indeed may, perhaps, if it be ſtrong, a little ſhake or agitate the particles, that compoſe the glaſs, and thoſe may communicate ſome of their motion to the contiguous parts of the water: but why all this muſt amount to the turning of that water into ice, is more, I confeſs, by far than I can apprehend; eſpecially ſeeing, that though you long blow upon a glaſs of water with a pair of bellows, where there is not an imaginary wind, as Mr. *Hobbes*'s, but a real and manifeſt one; yet the water will be ſo far from being frozen, that our formerly mentioned experiments (of blowing upon thermometers) make it probable, that it will ſcarce be cooled. And if ſea-ſalt do contain ſo much air, by virtue of which, it, as well as the ſnow, produces ſo intenſe a degree of cold, how chance, that being reſolved in a little water without ſnow, it does not produce at leaſt a far greater degree of cold than we find it to do? Beſides, in the experiment we made (and elſewhere mention) of freezing water ſealed up in bubbles, though the bubbles were ſuſpended in other glaſſes, whoſe ſides now here touched them, and the remaining part of whoſe cavities were filled ſome with air, and ſome with unfreezing liquors; what likelihood is there, that Mr. *Hobbes*'s inſenſible wind ſhould be able to occaſion ſo many ſucceſſive rakings through different bodies, as there muſt be, to propagate the congelative motion (if I may ſo call it) of the wind, through the firſt glaſs, to the included air or liquor, and through that new medium to the glaſs containing immediately the water, and through that to the innermoſt parts of the ſealed up water? And it might be further objected, if it were worth while, that Mr. *Hobbes* does not ſo much as offer at a reaſon, why ſpirit of wine, aqua fortis, or even brine, if it be of the ſtrongeſt ſort, are not either by this mixture, or (here in *England*) by the wind in open air, turned into ice, as well as many other liquors are.

See the 4th Section of the Hiſtory of Cold.

21. The reaſon, why cold is wont to be more remiſs in rainy or cloudy weather, than in that which is more clear, is not better given by Mr. *Hobbes*, than by ſome others, that have written before him: for, not to mention, that I have ſeen great froſts, and laſting enough in cloudy, and ſometimes very dark weather, that which he talks of the wind's being more ſtrong in clear weather than in cloudy, is of no great importance; ſince common experience ſhews, that in clear weather the air may be very cold, and the froſt very great, where no wind is felt to rake (as he would have it) the ſuperficies of the earth. Nor does experience bear witneſs to what he not warily enough pronounces, that the leſs the wind is, the leſs is the cold. There are but two phænomena more, which in this ſection Mr. *Hobbes* pretends to explicate: the one is, that in deep wells the water does not freeze ſo much, as it does upon the ſuperficies of the earth. But the reaſon of this we elſewhere take occaſion to conſider, and therefore in this place we need only note, that Mr. *Hobbes* has not rightly aſſigned it, by aſcribing it to the wind's entring more or leſs into the earth, by reaſon of the laxity of its parts; ſince beſides that it is very improbable, that the wind ſhould not, as he ſays it does not, loſe much of its force by entring into the earth at its pores, and other leſſer cavities (for that ſeems to be his meaning by the laxity of the earth's parts) to ſo great a depth as water lies in ſeveral wells ſubject to freezing: beſides this, I ſay, experience teaches us, that wells may be frozen, though their orifices be well covered, and the wind be thereby kept from approaching the included water by divers yards; and very many wells, that are ſubject to freeze, when northerly and

easterly

See the Examen of Antiperiſtaſis.

eaſterly winds reign, will likewiſe be frozen in very cold winters, whether any winds blow, or not.

22. The other, and laſt phænomenon, Mr. *Hobbes* attempts to explicate, is, that ice is lighter than water. The cauſe whereof, ſays he, is manifeſt from what I have already ſhown; namely, that air is received in, and mingled with the particles of the water, whilſt it is in congealing. But that this is not the true reaſon, may be argued from hence, that if a convenient glaſs-veſſel be filled topfull with water, and expoſed either unſealed or ſealed to congelation, the ice will have ſtore of bubbles, which, at leaſt in the ſealed veſſel, cannot by Mr. *Hobbes*, who will not affirm glaſs to be pervious to the air, be pretended to proceed from bubbles, that got from without into the water, whilſt it was in congealing. And we have ſometimes had occaſion to manifeſt, by particular experiments purpoſely made, how little of air there is even in thoſe bubbles, that are generated in ice, made in veſſels, where the air was not kept from being contiguous to the water.

See the 9th Title of the Hiſtory of Cold.

23. And thus have we gone through Mr. *Hobbes*'s theory of cold. In his propoſing of which, we wiſh'd he had in divers places been more clear; and in our curſory examination of which we have ſeen, that moſt of the particulars are either precarious or erroneous; and were they neither, yet the whole theory would, I fear, prove very inſufficient. Since an attentive reader cannot but have marked, that this learned author has paſt by far the greateſt part even of the more obvious phænomena of cold, without attempting to explicate them, or ſo much as ſhewing in a general way, that he had conſidered them, and thought them explicable by his hypotheſis: by which he, that will fairly explain all the phænomena recited in the notes we have been drawing together, and which yet contain but a beginning of the Hiſtory of Cold, ſhall give me a very good opinion of his ſagacity.

## A POSTSCRIPT.

THOUGH the haſte I am obliged to comply with, keep me from annexing the hiſtorical papers, wherewith I had thoughts to conclude this book, concerning cold; yet ſince the nature of the paſt Examen gave me but little opportunity to teach the reader any thing more conſiderable, than that Mr. *Hobbes*'s doctrine is erroneous; I am very inclinable to make him here ſome ſuch little amends, as the time will permit, for that paucity of experiments. And therefore ſince in the laſt ſection of the foregoing Hiſtory, upon occaſion of an experiment very imperfectly, and not intelligibly delivered by *Berigardus*, I intimate my having elſewhere plainly ſet down either the ſame he meant, or one of that nature, and that with conſiderable phænomena unmentioned by him; I chuſe rather to borrow ſome account of it from another treatiſe, to which it belongs, than not to gratify ſome of the curious to whom the phænomena I ſhewed them of it, ſeemed no leſs pretty than ſurprizing.

The way then I uſed in making this experiment, may be gathered from the following directions.

Take of good unſlaked lime three parts (or * thereabouts) of yellow orpiment one part, of fair water 15 or 16 parts; beat the lime groſly, and powder the orpiment,

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* According to the goodneſs of the lime, of which, if it be very ſtrong, two parts may ſerve the turn; and which, if it be too weak, may make the experiment miſcarry.

(with care to avoid the noxious duſt, that may fly up *) and having put theſe two ingredients into the water, let them remain there for two or three hours, or longer, if needs be, remembring to ſhake or ſtir the mixture from time to time. By this means you will obtain a ſomewhat fetid liquor, whereof by warily decanting, or by filtrating it, the clear part muſt be ſevered from the reſt.

In the mean time, take a piece of cork, and having lighted it ſo, that it is kindled throughout, remove it from the fire, whilſt it is yet burning, and by a quick immerſion quench it in fair water. And having by this means reduced it to a coal, you may (in caſe you have not erred in the operation) by grinding it with a convenient quantity of gum-water †, bring it to the colour and conſiſtence of a good black ink, that you may uſe with an ordinary pen.

Whilst theſe things are doing, you may take what quantity you think fit of common minium ‡, and two or three times its weight of ſpirit of vinegar, (which needs not be for this purpoſe much ſtronger than phlegm, and to which even undiſtilled vinegar may be a ſuccedaneum) and putting the powder and liquor into a glaſs phial, or any other convenient veſſel, let them infuſe over hot embers, or in ſome conſiderably warm place for two or three hours more or leſs, till the liquor have acquired a very ſweet taſte.

All things being thus prepared, take a new, or at leaſt a clean pen, and write with it ſome ſuch thing, as you either deſire or need not fear to have read, between (if you pleaſe) or, which is ſafer, || over the lines, which contain your ſecret, and which are to be traced with the ſolution of minium; for this liquor, if it be either well decanted or filtred, will be ſo clear, that what is written with it by a new pen, will not be ſeen on the paper when it is dry.

Lastly, When you would ſhow the experiment, dip a ſmall piece of ſponge, or a linen-rag (or, for a need, a little paper wreathed) in the water, that was made with lime and auripigmentum, and with this liquor, which, though it ſmell ill, will look limpid and clear, wiping over the paper, it will preſently, at once, both wipe out or obliterate what was written with the black ink, and make all that was written with the inviſible ink, though perhaps in the ſelf-ſame lines, appear black, ſo as to be very eaſily and plainly legible.

This is the way, to which many years ago my trials led me, of making this odd experiment. For the performing whereof, if any can propoſe a more eaſy and better way, (for I find by an inquiſitive § traveller, that there are more ways than one) I ſhall willingly learn it. In the mean time, the reader may perceive, that I did not cauſleſly intimate, that the learned *Berigardus*, though he would manifeſt a great thing in philoſophy by this experiment, did yet either not underſtand himſelf that part of it he pretends to teach, or has omitted one of the main ingredients of the water of orpiment he ſpeaks of. For I did not find, that even by a long infuſion,

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* To prevent which, I uſually cauſe the orpiment to be beaten, wrapt up in divers papers, or ſome other way ſecured from avolation, and from harming the veſſel wherein it is pounded.

† Which for this uſe it will ſuffice to make by diſſolving gum-arabick in a little fair water.

‡ This is known in the ſhops by the name of red lead, and is here ſpecified, as being cheap and eaſy to be procured, though I ſuppoſe, that other calxes or powders of the ſame metal, if they be not ſophiſticated, may ſerve the turn.

|| If you write firſt with the black ink, and then with the ſolution, the lines muſt be made ſomewhat diſtant, that thoſe, which expreſs your ſecret, may have room between the others; and therefore the better to avoid ſuſpicion, I choſe rather to write firſt with the inviſible ink, and then over that with the black, as if I had writ on an ordinary piece of white paper, by which means I could write the black lines as cloſe as I pleaſed.

§ That learned gentleman Mr. *H. Oldenburg*, ſecretary to the Royal Society.

nor by ſome decoction of the orpiment alone (without the quick-lime) there would be produced a liquor, either obviouſly fetid, or that would perform ſo much as a leſs matter, than what that, which he mentions, ſhould. And whereas he ſeems to commend this way (though but between lines written with common ink) for the writing of things one would not have to be diſcovered, and though I have yet met with nobody, that having ſeen the experiment, is not of his mind; yet I remember, that when, many years ago, I was making trials concerning the ſeveral ways of making inviſible inks, my conjectures led me to diſcover, that I could very readily bring what was written, with a ſolution of minium, to be legible by the help of a fire; as well as I could alſo detect by the ſame way ſeveral inviſible inks, which are believed to require appropriated liquors to make them confeſs their ſecrets. But I muſt reſerve the reflections, and other particulars, that relate to this experiment, for the treatiſe, to which it belonged. Only I will now add, that beſides the above-ſpecified motives to communicate what I have at preſent written of it, I was the rather induced to do ſo, becauſe I had mentioned, but not taught this experiment, in the Hiſtory of Whiteneſs and Blackneſs; and becauſe alſo *Berigardus* is not the only author of note I have met with, that having made particular mention of the experiment, has given the curious but a lame and unſatisfactory account of it.

# ADVERTISEMENT to the READERS

## Of the following EXPERIMENTS,

### By the AUTHOR of the foregoing HISTORY.

AT the ſame time that the Royal Society required of me an account of what I had obſerved, or tried, concerning Cold *, they recommended the making of trials about that ſubject to the learned Dr. *C. Merret*, who having diſpatched what he intended, much earlier than I could bring in my far more voluminous papers, he long ago preſented his to that Illuſtrious Company: and ſince that, has thought fit to let them indear my treatiſe, by their being annexed to it, and compoſing a part of it; and that ſuch a part, as much might be ſaid of it, if after I have informed the reader of its having obtained the thanks of a ſociety, that is too much accuſtomed to receive and produce excellent things, to be ſuſpected of valuing trifles, I could think it needful and proper to give thoſe papers any other elogium. And it falling out fortunately enough, that the doctor and I (being at ſome miles diſtance) did not communicate our deſigns to one another; as I knew nothing what he had been doing, till I heard it publickly read at *Greſham-College*, when far the greateſt part of my experiments were (as is known to more perſons than one) already recorded; ſo I afterwards ſcrupulouſly abſtained from borrowing the trials mentioned in his papers, to inrich mine. Which forbearance was the more eaſy to me, becauſe after the firſt time I heard thoſe papers read, I never deſired a copy, nor had a ſight of them. By this means it happened, that beſides thoſe many titles, which being handled at large in the hiſtory, are left untouched in the following tract, even on thoſe occaſions, where the learned doctor and I happen to treat of the ſame ſubjects, our trials are but very few of them coincident; upon which ſcore the reader will meet with more variety betwixt us, than probably he would have expected to find on ſuch an occaſion.

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* This is pointed at in the firſt page of the following account, where mention is made of an honourable perſon, &c.

HAVING drawn up this advertiſement about the doctor's papers, as ſuppoſing them the very ſame he preſented to the Royal Society; upon a ſight of the following ſheets, (as they were ſome hours ſince brought me from the preſs) the additions I there find, make it appear neceſſary to ſay ſomething further to the reader. I muſt inform him then, that about the middle of this winter, and about the end of *December* 1664, I preſented to the Royal Society ſeveral books, containing each of them eighteen or nineteen of the twenty-one titles, whereof my hiſtory conſiſts; that the Virtuoſi might have the opportunity of the cold (which then began to be ſo ſtrong, as to keep the preſs from diſpatching the reſt of the book *) to examine my experiments, and add to them: and one of theſe being delivered to the doctor, as the likelieſt perſon to make uſe of it, together with an order to the ſtationer, to let him have the remaining ſheets of the book, as faſt as they ſhould from time to time be printed; he had the curioſity, as to enlarge ſome of the things he had already tried, and brought in himſelf, (as is intimated in page 711) ſo to make trial of ſome particulars, that I had propoſed and performed, which either their importance, (as the way of freezing from the bottom upwards, by me ſuggeſted, and the weight of bodies frozen and unfrozen) or his opportunity invited him to make choice of; and has been pleaſed to afford them place among his own experiments †; by which means, though the coincidence of what we deliver will appear to happen more frequently, than the advertiſement will make one expect; yet to ſuch readers, as do not prefer variety before certainty, the coincident paſſages will not, in likelihood, be unacceptable. For, in thoſe caſes, where the events of our trials are the ſame, it is like the truth will be the more confirmed ‡; and in caſes where the ſucceſſes are very differing, the reader will be excited to make farther trials himſelf, and will be thereby enabled to judge, which trials have been the moſt carefully made, and the moſt warily delivered. And, though I think it but a neceſſary profeſſion for me, to ſay on this occaſion, that I am pretty confident of my having performed my duty, as to the hiſtorical part; yet this need not hinder, but that moſt of the differing ſucceſſes, we are ſpeaking of, may prove but inſtances of the truth of what I long ſince admoniſhed the Reader (in my preface) that there are among the experiments of cold, divers, that are liable to contingencies; ſo that, as I would not have the papers of this learned man comprehended in what I ſaid of the jejuneneſs of the writers I had met with, who treat of cold, in a preface written, when I was not ſure the following papers would not be made publick; ſo I hope the reception of theſe papers of this ingenious perſon will be ſuch, as may invite him to haſten the publication of thoſe fruits of his learning and induſtry on another ſubject, which divers of the Virtuoſi do not more expect, than deſire, to have communicated to them.

The Art of Pottery.

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* See the publiſher's advertiſement to the reader.

† Among which I am ſince informed, that he had tried divers, before he ſaw my papers.

‡ So one of the chief paſſages of the Examen of Antiperiſtaſis is much confirmed by page 711, following; which contains an account of a trial made by the command of the Royal Society, to whom it was propoſed by the Author of the Examen, with a requeſt, that they would pleaſe to order it to be made.

# AN
# ACCOUNT of FREEZING,

## Made in DECEMBER and JANUARY, 1662.

SINCE the buſineſs of freezing is obnoxious to many various contingencies, I muſt neceſſarily premiſe theſe following circumſtances. That theſe experiments were made in very hard weather, yet with ſome alternate relaxations, the froſt continuing above ſix weeks. And the place I choſe was in ſtone windows, expoſed to the North, and North-eaſt winds, and ſome upon the ground. The veſſels were glaſs-canes of ſeveral bores; earthen and pewter, ſmall pans and porringers; ſpoons of pewter and ſilver; glaſſes of various figures, as phials, cylindrical, round and ſquare; flaſks, recipients, bolt-heads, and ſome conical ones. Moſt whereof, by the diverſity of their figure, their openneſs or cloſeneſs, produce various effects in freezing, as the following obſervations will ſhew. The quantity alſo of the liquor expoſed is to be conſidered; for what will ſhew a ſmall thin plate of ice in a ſmall parcel of ſome liquors, will ſhew none in a greater.

THE method I ſhall follow in delivering my obſervations ſhall be, firſt, to run over the various liquors or bodies, whether fluid or conſiſtent, ſimple or compound, *&c.* uſed in this work. Secondly, what figures obſervable in thoſe ices. Thirdly, ſome effects ariſing thence. Fourthly, ſome properties and qualities. Fifthly, ſome lets or helps both to freezing and thawing. Sixthly, ſome uſes of ice.

IN purſuance of which particulars, I had recourſe to thoſe ingenious queries of Mr. *Henſhaw*, regiſtered in your *Cimelia*, and then to *Bartholinus*, in his late book *de Nive*, and to my own collected notes from various authors, adding whatſoever trials I thought meet. And in all theſe I have barely ſet down matter of fact, neither mentioning the authors, nor their errors, which would have been both nauſeous and tedious; nor ſhall I endeavour to render a reaſon of the various Φαινόμενα, (which cannot be done without a volume) but ſhall leave that province to an honourable perſon of this ſociety, who hath had much experience and reflections on this ſubject. And now to my taſk.

As to my firſt head of things uſed, I ſhall begin with common water, which I expoſed in a triple ſtate, in like quantities, and in open pans, *viz.* firſt, cold; ſecondly, boiling hot; thirdly, an equal mixture of both the former. The effect was this; the cold was frozen in one hour, the boiling hot in two hours, and the mixt in an hour and a half; but with this difference, that the cold did freeze firſt at the top, and ſides, and had a large thick cruſt before there was any ſhew of ice in the boiling hot; but the mixt and boiling hot began to freeze firſt at the bottom of the veſſels, and when the top was cold, then it freezed there alſo, leaving betwixt the bottom and top of the veſſel a cavity for the water, which in time was wholly converted to ice. The ſame ſucceeded moſt manifeſtly on theſe waters poured on a ſmooth table, where the cold water was preſently frozen, before the boiling hot water could become cold at the bottom.

WATER exhauſted of air in Mr. *Boyle*'s engine was frozen almoſt as ſoon as a like quantity expoſed in an open pan; the ice whereof appeared white, and to conſiſt purely of bubbles. The glaſs uſed was a four-ounce round phial, and a ſmall tube one foot long half filled with water.

FAIR water, wherein arſenick had been infuſed eight months, congealed much ſooner than a like quantity of water, into a very white ice.

SOLUTIONS of all the ſorts of vitriols freezed ſooner in pans and tubes, than water, or any ſolution of the other ſalts by much, though that of allum came very little ſhort of it. The ice kept both colour and taſte upon the leaſt touch of the tongue, in all of them.

A SOLUTION of allum did freeze into an ice whiter than milk, and ſtuck ſo cloſe to the ſides of the pan, that it could hardly be ſeparated from it: this was the firmeſt ice offered to me in all my trials; next to which, in both theſe qualities, were the vitriols, eſpecially the Roman.

SANDEVER quickly freezeth, frit ſooner than it, and kelp than them both; all of them into lumps very white, and conſequently not diaphanous.

SAL ARMONIAC ſhewed ſome variety in point of time; for in the ſame pan, quantity, and place with the other ſalted waters, it would, for the moſt part, freeze long after the former, though once it did freeze before them.

COMMON ſalt two drachms diſſolved in four ounces of common water (for that proportion I obſerved in all my ſolutions) did, in 30 hours ſpace, in the hardeſt ſeaſon, turn to pretty hard and white ice; whereas the former ſolutions became ſo in two or three hours at the moſt.

A BEER-GLASS was filled with ſtinking ſea water full of ſalt, which within 26 hours acquired at the top a plate of ice of the thickneſs of half a crown-piece, with few bubbles in it. This taſted ſalt and ſtinking as before, but being diſſolved at the fire, or thawed of itſelf, the ſtinking taſte was gone, but the ſaltiſh continued. The reſidue in the glaſs within four days (the ſeaſon continuing) and plates taken off (once in twenty-four hours) was frozen throughout, but that at the bottom of the glaſs ſeemed to have a much briſker taſte than that at the top, neither was it ſo firm and friable as that. I tried another beer-glaſs with the ſame water, which froze moſt part of it, but the ſeaſon continued not ſo conſtantly ſharp ſo long together, as in the former experiment, and therefore I could conclude nothing therefrom. But in ſmall broad earthen pans ſet in ice, in 36 hours the ſame water became ice throughout, and with the addition of a parcel of ice or ſnow much ſooner.

SOME water is impregnated with as much bay-ſalt, ſome with as much ſalt-petre, ſome with as much ſal armoniac as the water was capable to receive, and neither of theſe did congeal with the higheſt degree of cold, continued ſix days together.

A SOLUTION of ſalt of tartar ſoon converted into ice, but in much longer time than common water. I obſerved, that it began to freeze in a tube at the top, bottom, and ſides firſt, leaving the liquor in the middle unfrozen; whereas other ſolutions and liquors congealed uniformly, by deſcending, or aſcending, or both at the ſame time, from ſide to ſide through the middle. Of this I made but one trial.

SALT-PETRE required 28 hours in a very cold ſeaſon, and in that time became in the open pan a moſt pure white ice perfectly like ſal prunellæ, which an apothecary miſtook it for. This ice thrown into the fire (after the aqueous humidity was evaporated) did ſparkle as that ſalt uſeth to do. A ſtrong lixivium made hereof with an addition of copperas or allum ſingly, or mixt, ſet in ſnow and ſalt, or ſnow alone, was frozen in one night.

SAL GEM alone of all the ſalts, though ſnow and ice were mixed with it in great proportion, and though the pan was ſet in ſalt and ſnow, could not all that time be brought to congelation; an odd experiment. Phlegm of vitriol did freeze ſooner than the ſolutions before-mentioned.

OIL of vitriol begins congelation (or coagulation rather) near as ſoon as fair water. A pretty large tube was filled ¾ full with this oil, and about ¼ thereof was frozen, the reſt remaining at the bottom uncongealed. This tube was broken in the preſence, and by the command of this honourable ſociety, the coagulated part whereof was taſted by many then preſent, and concluded by all thoſe, that it was a ſtrong vitriolate taſte. This coagulated part was of a paler colour than the other, and both theſe mixed and poured into a phial-glaſs heated it ſo hot, that none there could hold it. This coagulated part kept ſo in the air a week after all my other liquors had been thawed, and would, in probability, have continued ſo much longer, had not the glaſs been broken. I expoſed another leſſer tube with the ſame oil, which became frozen throughout, and required very much relaxation in the air to return its former fluidity.

I HAD ſet a mark on theſe tubes (as on all the reſt, to obſerve their ſeveral riſings) and the oil of vitriol, when coagulated, ſunk more than half an inch below it, and being diſſolved at the fire, returned to its firſt ſtation, as you alſo ſaw. And this Φαινόμενον is peculiar to this oil alone, all other liquors riſing higher than the mark.

I NOW come to my ſtronger liquors of beer, ale, and wines.

I EXPOSED at the ſame time a flaſk of ſmall beer, and another of ſtrong ale; the former whereof was frozen throughout in 38 hours, but three pints of the ale continued unfrozen after ſix days continuance of very hard weather. And the air then diſpoſed to thawing, I broke the flaſk, and with the unfrozen liquor made an excellent morning's draught at four in the morning. This ale in colour, ſtrength and quickneſs ſeemed to me and the other three taſters that ſate up with me, much better than when it was firſt put into the flaſk, and by comparing it with ſome other in the houſe of the ſame barrel, we plainly found the ſaid difference. After this I took the icy part of the ale, and thawed it at a fire, which was in all a pint of liquor (though the flaggon contained three pints of liquor, was filled with the ice) was very pale, and of a quick and aliſh taſte, very much reſembling that drink, which the brewers call *Blue John*. This ice was not ſo firm as that of water, but fuller of bubbles.

I ASSAYED the ſame a ſecond time, but could not, by reaſon of the changeableneſs of the weather, attain ſo great a thickneſs of ice as in the former. And in this alſo I found the ſame changes as before.

A BEER-GLASS of *Hull*-ale in twenty-four hours contracted a cruſt of ice as thick as an half-crown, and proceeding, as in ſea-ſalt water, the Φαινόμενα were the ſame, all the laminæ taken off appeared of the ſame colour and taſte, and the loweſt ice was the moſt tender. Another glaſs of the ſame ale expoſed did not freeze throughout (no cruſt being taken off) in five days, when my own ale did in a like glaſs, both being ſet out together. Now the taſte and colour appeared the ſame, or at leaſt had no ſenſible difference, when they had been thawed of themſelves, and when firſt expoſed. *Hull*-ale hath a brackiſh taſte.

CLARET very ſtrong expoſed in a ſpoon, in 35 hours hard freezing became an ice all of it; it was ſoft, kept its former colour and taſte, ſoon diſcovering to the tongue of one who knew not whence it was, its nature, quality, and kind.

CANARY at the ſame time in a ſpoon expoſed, in 38 hours acquired on its ſurface an exceeding thin plate of ice, as thin as the fineſt paper, and proceeded no farther in four days following.

NEITHER claret nor canary would ſhew the leaſt ſign of congelation in tubes, much leſs in bottles.

Two ounces of the beſt ſpirit of wine expoſed in an earthen pan did all evaporate in leſs than twelve hours, but the ſame quantity of brandy left near a ſpoonful of inſipid ice without any taſte of the ſpirit, which caſt into the fire flamed not at all. I could diſcern no bubbles in this phlegmatick ice, but having interpoſed it betwixt mine eye and a candle, it manifeſted many bubbles by its ſhadows. Query, whether this may not turn to profit in colder countries in rectifying ſpirits of wine?

WE now come to conſiſtent bodies, and ſhall begin with animals, and their parts.

Two eyes, the one of an ox, the other of a ſheep, in one night were both totally frozen; the three humours were very hard, not ſeparable one from another, neither of them diaphanous, as naturally they are; and the cryſtalline was as white as that of a whiting boiled. The tunicles, fat, and muſcles were alſo frozen, as appeared by their ſtiffneſs, and by putting them into cold water. The ice of the wateriſh and glaſſy humours ſeemed to be made of flakes.

A PINT of ſheep's blood did freeze at the top, and all the ſides of the diſh, wherein it was put, and was nothing elſe but the ſerum of the blood. This ice being ſeparated from the blood, and thawed at the fire, and then again expoſed, congealed into a ſeeming membranous ſubſtance, and was taken for ſuch by ſome that ſaw it, and ſo continued in a warm ſeaſon, and appeared in all reſpects a membrane. This alſo was ſeen and regiſtered in the journal. The blood remaining gave me no ſigns, that froſt had taken it.

I DISSECTED a dog and a cat, having lain dead in the open air, and found their entrails, nay, the very heart ſtiff, and ſome little ice in the ventricles of their hearts, and their *vena cava*.

MILK ſoon freezeth into moiſt white flakes of ice, retaining the proper taſte of milk; theſe flakes are ſoft, and manifeſt not many bubbles.

SEVERAL eggs were expoſed, and both yolk and white in one night were hard frozen. They require a longer time to freeze than apples do. The beſt way to thaw them both, is to lay them on *Newcaſtle*-coal, or in a deep cellar. Whether eggs once frozen will produce chickens or no, I cannot ſay, but have been told by good houſe-wives they will. Some affirm, that eggs and apples put into water, the ice will be thawed within them, and the ice appear on the ſhell and ſkin. It is true, if you hold either of them near the ſurface of the water, they will ſoon gather a very thick cruſt upon their outſides; but if you then break the one, or cut the other, you ſhall ſee them full of ice, and the eggs then poached will taſte very tough. So that this ice ſeems to be gathered from without, and not come from within. And beſides if it did ſo, they muſt needs loſe their weight, the contrary whereof will anon appear. But for the more ſurety, I proceeded to this farther experiment. I immerſed in my ciſtern an egg, and an apple, two foot deep into water, and there ſuſpended them with ſtrings tied about them, to keep them from ſinking for the ſpace of twenty-four hours, and then took them out, and opened them. I could never obſerve in that time, though I often looked at them, any ice on their outſides, and the one being broken, and the other cut, were found both of them full within of ice.

THE next order ſhall be vegetables, and of them a few inſtances, eſpecially thoſe which are of a biting or ſour taſte. Now for the firſt, I employed the roots of horſeradiſh and onions, (for other edible roots and plants every one knows will freeze) which ſhewed the froſt had taken them by their taſte, and ice was found betwixt each of the ſkins of the onions, retaining the taſte of the root; yet I have obſerved beer, wherein horſe-radiſh and garden-ſcurvigraſs have been infuſed, will not freeze ſo ſoon as other ſtronger beer without them.

ORANGES and lemons frozen have a tough and hard rind, their icy juices loſe much of their genuine taſte; they were both frozen hard in 26 hours, or a little more, having a thick rind. They, as other fruits, when thawed, ſoon become rotten, and therefore the fruiterers keep them under-ground in low cellars, and cover them with ſtraw, as they do their apples.

WHICH did, expoſed in one night, freeze throughout. If you cut one of them through the middle, it will have on both the plains a moſt pure thin ice, hardly diſcernible by the eye, but eaſily by the touch, or by ſcraping it off with a knife. The cores of theſe apples ſoon turn brown, and begin their corruption there.

OIL expoſed did acquire the conſiſtency of butter melted, and cooled again; but in caves and cellars I could never ſee it more than candy.

STRONG white-wine vinegar did all ſoon freeze in a tube, and without any apparent bubbles.

AND to conclude, without mentioning nuts, bread, butter, cheeſe, ſoap, and many other things, which came under my trial, it is moſt certain, that whatſoever hath any wateriſh humidity in it, is capable of congelation: what are not, you have in the next paragraph.

HAVING now done with what will freeze, I ſhall briefly recount ſome things, whereon the cold hath no ſuch effect.

WE mentioned before ſpirit of wine: add to it ſuch ſtrong waters as are made of it, *viz.* aqua Mariæ, cœleſtis, *&c.* and canary wines in larger veſſels. Secondly, the ſtrong lees of ſoap-boilers, and others made of other ſalts, to which refer the ſpirits extracted from ſalt; vitriol, ſalt-petre, aqua fortis, and ſpirit of ſulphur, which laſt precipitated to the bottom of the tube a ſmall quantity of powder, very like in colour to *ſulphur vivum*, which being ſeparated from the ſpirit (for nothing of that evaporated) cracked between my teeth, and taſted like brimſtone, and being put into water, made it as white as lac ſulphuris doth, but it would not flame, perhaps becauſe too much of its ſtrong acid ſpirit was mixed with it. Spirit of ſoot afforded alſo a precipitation or ſediment (the ſpirit not congealing) at the bottom of the tube of a yellowiſh colour, but much bitterer than the ſpirit itſelf, and inflammable alſo.

BUT here it is to be obſerved, that the ſaid ſpirits, that would not freeze alone, yet with the mixture of about 12 parts of water, or leſs of ice, or ſnow, did freeze throughout; except the ſpirits of ſalt, of nitre, and aqua fortis, which would not freeze with thoſe quantities of water, ice, and ſnow. I intended to have tried them with a greater quantity of the ſaid ingredients, but the weather failed me.

WHETHER the ſalt-water freeze in the ſea, I cannot experimentally determine; but I ſhall add what was told me by one, that ſaid he had diſſolved ice in the northern ſeas, and found it very ſalt.

THE next propoſed was the figure of liquors frozen; wherein I ſhall obſerve in general, that moſt of the liquors differed from one another in their figures, and being permitted to freeze, and thaw often, they ſtill returned to the ſame figure, moſt whereof were branched. Allum appeared in lumps; ſalt-petre, tartar, milk, ale, wine, and ſal armoniac in plates; and other liquors mentioned to freeze into a very ſoft ice, ſeeming to be made up of ſmall globuli adhering each to other. Fair water, kelp, and the frits reſembled an oaken leaf, the leafy parts being taken away, and the fibres only remaining, the interſtitia being filled up with ſmoother ice. The middle rib (if I may ſo ſay) as in plants was much bigger than the lateral ones, all which ſeemed but different ſtiriæ, whoſe points extended towards the outſide of the veſſel containing the water, and made acute angles with the middle rib towards the leſſer end of the ſaid leaf.

Concerning the figures of frozen urine I ſhall ſay nothing, the accurate deſcription of curious Mr. *Hook* having ſo fully and truly performed that part of my taſk.

Now as to the famous experiment of *Quercetan*, and affirmed by many other chymiſts, I made experiments in theſe following vegetables; roſemary, rue, ſcurvigraſs, mints, and plantane, wherein I thus proceeded: I mixed with ½ a pint of their diſtilled waters ½ or ¾ of an ounce of their own ſalts; the roſemary and rue were calcined, and their ſalts extracted with their own waters, and then were added to their ſalts their own diſtilled waters in the above mentioned proportions. The glaſſes, wherein the rue and plantane were put, being ſealed with *Hermes*'s ſeal, and the other glaſſes left open, the effect was, that neither of them ſhewed the leaſt reſemblance of the plants, from which they were extracted, neither figure, nor ſhew of roots, ſtalks, branches, nor leaves, (but only a lump or heap of ſmall globuli) much leſs of flower or ſeed. Beſides the kelp frozen hath many fibres, which is made the moſt of it of *alga marina*, whoſe leaf is long and ſmooth without fibres in it. This one thing I cannot pretermit, that the ſcented waters ſeemed upon their thawing to have acquired, and advanced much in their ſcents, and eſpecially the roſemary, whoſe ſalt hath no ſmell, and its water but little; yet thawed, they ſmelt as ſtrong almoſt as freſh leaves rubbed and ſmelt to.

A large recipient was filled with water, which being frozen throughout, and the upper cruſt of the ice broken, there appeared in the middle of it a multitude of thin *laminæ* of ice, ſome more, ſome leſs wide, from which proceeded *ſtiriæ*, or teeth pointing inwards, and ſet at pretty equal diſtances, ſo that the *laminæ* and *ſtiriæ* reſembled very much ſo many combs placed in no order, ſome lying directly, others obliquely, none tranſverſly, having intervals betwixt each of them; betwixt ſome of them I could put my finger without breaking the points of the *ſtiriæ*: theſe combs were placed round about a cavity in the middle of the receiver ſufficient to receive two of my fingers.

In a flaſk filled competently with water, when it was frozen, there appeared throughout the ice infinite ſilver-coloured bubbles, very like unto tailed hail-ſhot of ſeveral ſizes, the largeſt about ¼ of an inch long, where thickeſt, of the bigneſs of a great pin's-head, others much leſs in all dimenſions. The points of them all looked outwards, and the bigger part inwards towards the centre, where alſo were the largeſt. For there they would eaſily admit a little pin into all their cavity, without the leaſt reſiſtance. The figures of them were pretty regular: firſt, a ſmall thread, and then a head as big as a ſhot, and thence gradually ended in a point. Some of theſe were ſtreight, moſt a little crooked. There was a cavity in the centre of this ice filled with unfrozen water, from which I could find multitudes of cavities of bubbles, not fully formed. And in the more ſolid parts of the ice cut, you may diſcern them by a black ſpot, where the hole enters into the cavity. All the ſame phænomena appeared in a ſecond trial, but that the bubbles were ſhorter and larger, and not ſo ſharp pointed. The like I alſo obſerved in a conical glaſs ſealed up.

The next thing to be treated of, is the effects of freezing, *viz.* the expanſion of liquors frozen, and conſequently thereunto the breaking of bodies, wherein they are incloſed. All the liquors tried did ſenſibly in glaſs tubes riſe beyond my mark, before the liquors could ſenſibly be diſcerned to freeze, and after roſe ſomewhat higher with freezing. The height of the riſing I ſhall here ſet of a few experiments, inſtead of many made (having troubled your patience too long in the former paragraphs) in ſeveral proceſſes. Vinegar and urine roſe about half an inch, and lees made with ſalts of roſemary, kelp, the frits, about $\frac{1}{4}$ of an inch. Solutions of alum and copperas ſomewhat leſs, and in general the ſaline liquors leſs than water, which roſe a full inch, and ſmall beer in a very narrow tube four inches; but water in the ſmall capillary tubes could not be perceived, either to expand it ſelf, and certainly not to freeze at all. Oil of vitriol alone (as hath been ſaid) ſinks below the mark. Hot water put into a tube firſt ſinketh till it is cold, and then riſeth before it freeze.

Open-mouthed glaſſes, ſuch as beer-glaſſes, *&c.* filled with water up to the brim, when frozen, the ice will manifeſtly riſe above the ſuperficies, and make a ſolid triangle there. But narrow-necked glaſſes more plainly ſhew this riſing. In a flaſk filled with water four inches below the mouth, the ice roſe above the mouth, and hung two inches without it. And once in a bolt-head the ice roſe five inches above the water-mark. And here I ſhall briefly add two things; firſt, that if glaſſes be filled about $\frac{2}{3}$ full, they ſeldom break; but if more, they will for the moſt part break. Secondly, that round-figured or ſpherical glaſſes for the moſt part break in an uniform manner. I filled a bolt-head full to the neck, and ſtopped it at the top, which was twelve inches diſtant from the body, with a piece of melted candle. The ice roſe above three inches in the neck, and the glaſs broke in the thinneſt part of the body; from the point of breaking, as from a pole, the cracks run as ſo many meridians, but unequally diſtant each from other, and conſequently concurred not in an oppoſite pole on the other ſide; beſides there was great difference in the length of thoſe cracks, none whereof went round the glaſs. In a flaſk thus crack'd in many places, the cracks were very irregular in all the places; for ſome of them ran from their centers upwards, others downwards, ſome ſomewhat parallel, but moſt obliquely, and few of them were conſiderably ſtraight. Glaſs-bottles, and eſpecially ſtone-jugs, keep very little, and the laſt no method in their breaking: the ſame alſo befals ſquare glaſſes: woods follow their grain, and metals no order at all.

And now I come to ſome remarks proceeding (as I ſaid) from this expanſion, *viz.* the breaking of the veſſels, or force of freezing, wherein alſo you may take notice of that quality of cold, mentioned by the poet, *penetrabile frigus*, piercing where light comes not.

Two oval boxes, the one of box, the other of maple (both firm woods) containing each above two ounces of water, were filled full, and with ſcrews cloſed very faſt: both theſe boxes were rended from the bottom to the top in one night, with gaps big enough to receive a barley-corn into them: theſe woods ſtretch but little, and therefore break more ſurely, and with larger rents than ſofter woods will do.

Secondly, a pepper-box of latten made of iron, covered with tin, had the neck broken off, and holes made in the top near the neck; and the bottom, where it was ſoldered, was ſo diſſevered, that water would eaſily run out there.

Leaden pipes laid above ground were broken in many places. One I ſaw twenty yards long broken in ſeven places, and another in my cellar ſix yards long, broken in two places. I ſaw likewiſe in many places of this city leaden pipes, above a foot deep under ground, broken in ſeveral parts.

Cocks of ciſterns, and other braſs cocks, and alſo the barrels in pumps made of braſs or lead, uſually break with the froſt.

I exposed a copper box of a pear faſhion, which did bear three ſeveral freezings, by reaſon of the great extenſibility of that metal; but at the fourth eſſay it cracked all along one ſide of it, almoſt to the ſcrew.

NEXT I tried a cylindrical ſilver ink-horn; but that did bear five trials, and therein I could perceive neither crack, nor dilatation of its ſuperficies. I intended to have tried it in a ſmall bottle, but the weather failed me. I expoſed alſo a round ſilver ball of the bigneſs of a large nut; the ſilver became very ſenſibly extended to a larger ſuperficies, but did not ſuffer any ſolution of its continuity.

TOBACCO-PIPES, and all earthen-ware, taking any froſt in their drying, (before they are burnt), become very brittle, and being put into a ſtrong fire, will certainly break into many pieces. Tiles of houſes, and hard ſtones in buildings, ſcale and break off upon thawing; and thence it is, that the northern ſides of ſtones-buildings firſt decay, and moulder away, as it is moſt manifeſt in antient magnificent ſtructures.

ALABASTER and marble having any chinks in them frequently break with froſt; and the ſtatuaries tell me, they never ſaw any ſolid marble break: as for flints, paving-ſtones, precious ſtones, and ſuch as will receive a poliſh, the bitumens, as amber, kennel-coal, *&c.* I could never ſee any effect on them.

THE next effect ſhall be that of adheſion, concerning which take the following experiments.

A SMOOTH piece of ice was laid on a ſmooth table, and common ſalt thrown upon it; the effect was, that the ice ſtuck ſo firmly to it, that it could not be ſevered from the table, without breaking the ice into many ſmall pieces: and it will continue in this cloſe coheſion, till the ſalt hath corroded through the ice to the very table, (making many holes in the ice) and hath melted it to the very bottom. But if you lay ſalt firſt upon it, then the ice ſticketh not, but thaweth. Theſe following ſalts applied (as before common ſalt was) cauſe adheſion to the table, but not ſo firm as it, *viz.* kelp, ſandever, ſal Indus, gem. prunellæ, and armoniac, and pot-aſhes, but not alum, or vitriol.

THE next experiment of adheſion was this; I held a nail betwixt my lips in theopen air a very little ſpace, which ſtuck ſo firmly to them, that I could not pull it thence without difficulty and pain.

ANOTHER effect is concentration of ſpirits and colours. Concerning the former, you have already as much as I know, eſpecially in the paragraph of freezing beer and ale. Concerning the latter, take theſe following trials. Cochineal was boiled in water to a very high tincture, and frozen: and to twice four ounces of this decoction was added in one glaſs a little ſpoonful of ſpirit of wine, and in another as much ſea-ſalt-water: all theſe were frozen throughout, and every part of this ice ſeemed to me of an equal colour, though the edges, as thinner and nearer the light, appeared of a brighter colour (as they do unfrozen) but the glaſſes being broken, ſhewed no diſcernable difference in any of them, neither as to colour nor taſte. The like trials were made with madder weed and indico, and the ſucceſs was the ſame.

SECONDLY, I expoſed a pint pottinger full of the decoction of ſoot, which (the air relaxing) did only freeze an inch thick: this continued above a week conſiſtent (in a thawing ſeaſon) and very ſolid. Some, that ſaw it, judged it to be brown ſugar-candy, the taſte whereof was near, if not altogether as ſtrong as the uncongealed liquor remaining at the bottom. And in another trial, when the whole was frozen, no concentration was ſeen. But though it was not my hap to find this effect, my trials having been made in phials, ſquare, cylindrical or round, yet Mr. *Hook*, a worthy fellow of this ſociety, happily lighted on it, as you may perceive by his relation, and ſchemes of his glaſſes hereunto annexed.

SOME affirm, as an effect of freezing, an addition of weight made in the bodies frozen; but this affirmation anſwers not my trials. For in four eggs, and four apples fully frozen, I found the weight of them the ſame, when frozen, and thawed, as they had before they were expoſed; each of the eggs and apples being weighed in this triple ſtate both ſeverally and jointly: with the particular weights I ſhall not trouble you. Beſides, that freezing adds no weight, it is apparent in ſealed glaſſes, from whence nothing can expire, and by exact ponderation of them, I could not perceive any the leaſt difference in weight in the ſaid triple ſtate. This I tried ſeveral times with as much exactneſs as poſſibly I could, and ſtill found the ſame event.

ANOTHER property of freezing is to render many bodies more friable and brittle; as moſt woods, as alſo iron and ſteel, as every one knoweth, that hath uſed croſs-bows in froſty ſeaſons, and ſo likewiſe the bones of animals; and it is commonly obſerved by ſurgeons, that more men break their legs and arms in ſuch ſeaſons, than at any other time of the year, eſpecially ſuch, who have been tainted with the *Lues Venerea*, as *Hildanus* ſomewhere notes.

I SHALL now conclude the effects of freezing, by ranging them into good and bad. The good, are the long preſerving bodies moſt ſubject to putrefaction; healthineſs, and confirming the tone of all animals; and thickening the hairs and furs of ſuch as have them, fattening ſome. Beſides, it exceedingly clears the air, and other bodies, as it is manifeſt by the ſtinking ſea ſalt-water before-mentioned, as alſo by this that follows: namely, I took ſix of the moſt muſty ſtone-bottles I could procure, and competently filled them with water, which, after freezing and thawing again, became as ſweet as ever they were before.

BAD effects, are the killing and deſtroying animals and vegetables by congealing and ſtopping their vital and nouriſhing juices, rendering them totally immoveable. It is obſervable, that in *Greenland*, and *Nova Zembla*, nothing but graſs grows; as alſo what was told me by Dr. *Collins*, the preſent phyſician of the emperor of *Ruſſia*, that no thorny plant or thiſtles grow in that country. And this preſent year moſt of the roſemary and ſage about *London* was wholly deſtroyed, beſides moſt of the more tender plants.

MY fourth propoſal was the properties and qualities of ice, ſome whereof my taſk ingageth me to enumerate only; ſuch as are its ſlipperineſs, ſmoothneſs, hardneſs, whereby, and by its bulk and motion, it breaks down bridges, *&c.* its firmneſs and ſtrength to bear carriages, and burdens; its diaphaneity, which is much leſs than the liquor, of which it is made. For I could never diſcern any object, though but confuſedly, a foot beyond the cleareſt piece of ice, by reaſon of the many bubbles and luminous parts within it. Which bubbles ſhew only ſhadows, but the ice itſelf interpoſed betwixt your eye and a candle appears in many round circles, from which proceed many rays of light, four or five, or more, in the form of a ſtar of about ¼ of an inch in diameter, which ſo glaze your eyes, you can ſcarcely ſee any thing but bright light and ſhadow.

As for its penetration and thickneſs ſomething hath been ſaid above; to which I ſhall add, that I have ſeen the *Thames* ice of the thickneſs of eight inches, or more, near the middle of the river, and on the ſides much more. And in garden-walks the earth frozen near two foot deep; whereas on the other ſides of the ſame walks, on a richer mould, the froſt did not reach much above one foot and ¼, and pipes of lead have been broken above a foot under the ſurface of the ground. I ſhall not mention the huge mountains of ice found in the moſt northerly ſeas, but proceed to its weight.

IT is generally known, that ice ſwims upon the water. But I have ſeen ſnow-balls, moiſtened only with water, and then compreſſed with a ſtrong force, and afterwards frozen, to ſink: beſides, the congealed oil of vitriol deſcends in water, and common ice is frequently obſerved under water; whether the ſolutions of ſalts frozen will ſink, was by me forgotten to obſerve, and whether coagulated oil will ſink in unfrozen, as *Bartholine* affirms. Some affirm, that ſnow-balls hard preſſed, without addition of water, will ſink; but experience teacheth me the contrary.

As for its tactile qualities, every one knows it is colder than water, which you may increaſe by adding ſalt unto it, or rather ſnow.

SMELL it hath none, but it binds up that quality in all, but moſt ſpirituous bodies, which it alſo in ſome degrees refracts in them.

LASTLY, ice yields both reflection and refraction, whereof I ſhall ſpeak, when I come to its uſes.

MY fifth head was letts and helps in freezing, which I ſhall briefly diſpatch. Thoſe beſides the North and North-eaſt winds, the abſence of the ſun, and the higheſt parts of houſes or mountains, are the mixture of ſnow and ſalt (than which there is nothing more painfully and inſufferably cold to my feeling) as is apparent by the trick of freezing with ſnow and ſalt by the fire-ſide, as alſo by the ingenious way of making cups of ice, invented by an incomparable perſon.

ADD hereunto, that water falling or thrown upon ice or ſnow ſoon becomes congealed. A mixture alſo of ice beaten into powder, and mixed with common ſea-ſalt (which is beſt) or with kelp, allum, vitriol, or nitre. And here note, that veſſels filled with water, and ſet upon theſe mixtures, begin their freezing at the bottom of the liquor, and conſequently are not ſo ſubject to be broken, as thoſe are, which are not ſet in theſe mixtures, and that the water riſeth higher with, than without them. I find alſo, that oil of vitriol alone, mixed with ſnow or ice, have the ſame effect, though not ſo powerful.

ONE affirms, that ſalt-petre diſſolved in water, and put into a bolt-head, and long agitated, not only cools the hand exceedingly (which is very true) but alſo converts it to ice, yea, in the very ſummer months, which anſwereth not my trial, though kept a whole hour in that agitation in the hardeſt ſeaſon.

THIS following experiment alſo I add, propoſed to me.

I FILLED a bolt-head, containing a quart of water, and ſet in an iron pan, ſurrounding it on every ſide with ſnow, which covered alſo part of the neck; and then ſet the kettle over the fire, and took now and then the bolt-head from the fire, whilſt the ſnow was thawing, but not the leaſt ſign of freezing appeared in the water put into the bolt-head.

As for the helps of thawing, take this experiment. I ſet in the ſame cellar three pans full of ice, one on *Newcaſtle* coal, a ſecond on ſand, a third on the earthen floor; they thawed in the ſame order they are mentioned, which was thrice repeated, and once that placed on the coal did thaw, when the other continued their ice. Sealed glaſſes ſeem neither to promote or hinder this act of freezing. The ſame ſucceſs I had with eggs and apples in my cellar.

THE laſt thing I ſhall ſpeak to, is the uſe of ice. You may therewith make a ſiphon, being faſhioned and applied, as uſually ſiphons are; and this will happen, whether you make it one continued piece of ice, or two contiguous ones; for in both the water will run exceeding faſt, and this ſiphon ſoon empties all the water out.

A SECOND uſe is for refraction; whereof Mr. *Hook* hath given you already a learned demonſtration. And I having formed ſome ice into various figures, like moſt of thoſe mentioned by the dioptrick writers, the Φαινόμενα were the very ſame as in the like figured glaſſes; but how *Deſcartes* made dioptrick glaſſes of it, I know not, eſpecially to make uſe of them. And laſtly, you may make a ſpeculum of it, eſpecially if a piece of blacked paper be placed behind it, and if you hold a candle at a convenient diſtance, there will appear very many ſpeculums to your eye, according to the number of the bubbles contained in the ice. But I could not obſerve any heat proceed from ice, though cut in the true figure for burning-glaſſes, and expoſed in naked ice; but frozen in ſpherical glaſſes it will heat a little.

I SHALL here ſubjoin ſome propoſitions of the learned *Bartholinus*, taken from his book *De Nive*, being near to the former argument, who affirms,

1. THAT the more ſubtile diſtilled ſpirits gain a clear ſplendor and elegancy from ſnow placed about them.

2. THAT the rays from ſnow newly fallen glitter, and excel in a kind of ſplendor, wherewith the eyes are dazled. 'Both theſe are true, and have but one common cauſe, *viz.* the multitude of reflections cauſed by the infinite globuli, whereof every flake of ſnow conſiſts.'

3. THAT he ſaw cabbage growing in his garden, putrify on that part, which was above the ſnow. 'It is certain, that froſt alone, with or without ſnow, hath this effect on cabbage, being of the tribe of ſucculent plants; and I obſerved, that in the year 1644, our great houſe-leek, or American aloes (uſually hung up in houſes) kept in an upper room, was totally deſtroyed by the cold. And that apples will rot, I have ſaid before, and houſewives, to prevent the rotting of onions, commonly hang them up in their kitchins, or keep them in their ovens, or ſome cloſe place. And this preſent year 1662, I ſaw at Mr. *Box*'s, the eminent druggiſt's houſe, abundance of ſquills or ſea-onions quite rotten: they were laid in an open, but cloſe garret.'

4. WHEN ſnow melts by the ſun's heat, copious vapours from the earth clouded the ſun. 'He ſhould rather have ſaid, vapours from the melted ſnow; and 'tis no wonder, that vapours cloud the ſun.

5. SNOW melts and falls off from ivy. 'I have obſerved all the ſorts of ivies, and evergreens with us, and ſome biting plants too, but find in them all the contrary to what is here aſſerted. Nay, no difference hath been obſerved even in hoar-froſts, which fall equally, and continue on all ſorts of plants.'

6. He excludes not a ſmall portion of earth from ſnow, though pure, which, ſaith he, is manifeſt from diſtillation. 'This experiment I have found true by evaporation, which is tantamount to diſtillation; and indeed all melted ſnow leaves an earthy and foul ſettling behind it.'

7. VISCOSITY with ſoftneſs is greater in new than in old ſnow, and therefore it is brought into a maſs. 'Viſcoſity in it I underſtand not; its ſoftneſs indeed is manifeſt too, by the tracks of beaſts, which appear more fair, the ſnow not riſing on the ſides of the impreſſion made by their feet (as it doth in old) but retains their perfect character.'

8. WATER-CRESSES and ſcurvigraſs grow under the ſnow in gardens. 'I apprehend not, that any plant whatſoever grows at all in hard ſeaſons; my meaning is, that no plant acquires any greater bulk of quantity, but keeps at a ſtand only; and this countrymen affirm of graſs and corn, and gardeners of other plants. It is true many plants will upon thawing ſhew a finer verdure, and if warm weather preſently follow, all vegetables will thrive exceedingly. For how they ſhould thus grow, when their nouriſhing liquor is congealed, and conſequently become immoveable, I underſtand not.'

9. AIR is included in ſnow; 'which this way of mine to make ſnow fully convinceth. I took the whites of eggs, and beat them in the open air with a ſpoon,

into a frothy conſiſtence, as women do to make their ſnow-poſſets, and then taking a little of this ſubſtance, and laying it on a trenchard, it ſoon became plain flakes of ſnow, ſo that none, that ſaw them, could judge otherwiſe. Another accidental experiment proves the ſame; for having put water into a tube, and having long and ſtrongly agitated it, there aroſe many bubbles at the top, which ſoon freezing (my agitation ceaſing) became perfect ſnow. And now having here ſet down the way of counterfeiting, at leaſt, if not of making ſnow, I will add, how a pruina or hoar-froſt alſo may be imitated. ‘ I took a pail filled with warm water, and hung over ‘ it hair, moſs, and a piece of roſemary: now the atomical vapours riſing from the ‘ water, fixing themſelves on the moſs, hair, and roſemary, became on them a ‘ perfect hoar-froſt. The like is daily ſeen on the beards and hairs of men and ‘ horſes, travelling in cold winter nights or mornings, proceeding from their breaths, ‘ ſteams of their bodies, or moiſt atoms of the air. I tried alſo to make hail with ‘ drops of water, but could not hit on it, for they would never become white: ‘ Whence it is manifeſt, that hail is not drops of rain, ſuffering glaciation in the ‘ falling, as the received opinion of philoſophers aſſerts.’

10. Snow abounds with fat. ‘ This I underſtand not.’

11. Snow with ice ſwims on water. ‘ This is a clear conſequence from the ſeventh ‘ aſſertion.’

12. Snow-water boils meat ſooner, and makes the fleſh whiter. ‘ I tried this in ‘ fleſh and fiſh, but could find no manifeſt difference, either to their ſooner boiling or ‘ whiteneſs.’

13. Snow newly fallen hath no taſte, but lying long on the ground, or frozen, ſomewhat bites the tongue. ‘ My taſte was not ſo acute, as to diſtinguiſh the biting ‘ of one from the other. It is true indeed, that ſnow frozen doth more affect the ‘ tongue with its coldneſs, than ſnow alone.’

14. Worms are ſometimes found in ſnow. ‘ This neither my own obſervation, ‘ nor relation from others can make out.’

15. From ſnow, by a peculiar art, a ſalt of wonderful ſtrength is drawn. ‘ He ‘ ſaith not this of his own obſervation, nor teacheth the way to extract it.

16. After much ſnow plenty of nuts. ‘ This frequently ſuits with the country-‘ man's obſervation, but many times fails; ſuch years alſo commonly produce plenty ‘ of wheat, other ſeaſons concurring.’

I shall here alſo inſert two remarks out of the ſame authors concerning freezing. The one is, that the great duke of *Tuſcany* diſtilled ſpirit from wine, only by putting ſnow upon the alembick, without help of fire. The ſecond, that the duke of *Mantua* had a powder, which ſoon congealed water into ice, even in the ſummer.

And to conclude, take theſe general obſervations made by the command of the Royal Society, with weather-glaſſes framed after the *Italian* mode, and filled in part with tinged ſpirit of wine. Which I ſhall deliver briefly, and in groſs, and not each day's alteration apart. I took then two of the ſaid glaſſes of equal dimenſions, as near as might be, and filled them with the ſame ſpirit of wine; one of them I placed in my ſtudy-window, ſtanding north-weſt, the other in Mr. *Pullyn*'s ware-houſe under St. *Paul*'s church, and choſe there a ſmall receſs or room, which was moſt remote from the entrance, and the warmeſt in the whole ware-houſe. Both the glaſſes were ſettled in their ſtations the 15th of *October* 1662, the ſpirit in both having the altitude of three inches juſt. When the glaſs in my ſtudy was depreſſed by the cold an inch, I went and obſerved that in the ware-houſe to have received no manifeſt change in its ſtation. And at a ſecond viſit the ſpirit was depreſſed ¼ of an inch below, when that above ground was depreſſed near two inches. And during the long continuance of all that hard winter, it never deſcended above ¼ of an inch, and never was higher there than three inches and ¼ in a mild ſeaſon in *April* following, by which time the papers fixed to the glaſs, and whereon were fixed the degrees, were quite rotten, and the characters ſcarcely legible. And at the ſame time, that in my ſtudy was raiſed to four inches ¾. By which it appears, that the ſaid ware-houſe was in the coldeſt ſeaſon as warm as in a mild *March*, for at that ſtation the glaſs in my ſtudy ſtood commonly betwixt two inches and 2 and ½. And ſo indeed this place appeared to one, that went into it at the coldeſt ſeaſon. And to this purpoſe I ſeveral times ſent in at night my hardeſt frozen liquors, which were conſtantly thawed in the morning, though it froze exceeding hard above ground.

The glaſs in my ſtudy, after two days hard freezing, was ſunk below my marks into the very ball; ſo that I could make no further obſervations concerning the cold above ground.

From the former obſervations, that popular error is manifeſtly refuted, *viz.* that cellars and ſubterraneous places are hotter in the winter than in the ſummer; which, though they appear ſo to us, becauſe they warm us in the winter, and cool us in the ſummer, yet they are not ſo in themſelves: for it appears by the former experiment, that in the coldeſt ſeaſon the ſpirit was depreſſed to two inches and ¼, and roſe in *April* to 3½; and no doubt would have riſen about ¾ of an inch higher, had it continued there, till the hotteſt ſeaſon of the year.

One thing more I obſerved, *viz.* that the tinged ſpirit of wine had in this ſubterraneous vault totally loſt its colour, whereas that in my ſtudy (two years after) ſtill retains its former tincture.

Since the printing of the foregoing papers, *viz.* 1664, (there being no froſts in *England* 1663) I made theſe following experiments.

Finding the 3d of *January* the ſeaſon diſpoſed to freezing, I expoſed a pint bottle of claret, and a glaſs cane filled with canary, a ſolution of ſal gem, train oil, and the oil of *fructus muſæ*; and on the fourth of the ſame month, the night being the coldeſt and ſharpeſt that I ever felt, (which all I ſpake with the next day confirmed) the wind then blowing hard at ſouth-weſt, I found in the morning all the liquors frozen, except the ſal gem expoſed in an earthen pan, which ſhewed at the bottom of the diſh ſome ſeemingly cryſtallized ſalt; the oil of the ſame fruit became very friable, and of a milky white colour, but the train-oil only loſt its fluidity, and became of the conſiſtence of ſoft greaſe. And the ſame night a bottle of the Rheniſh wine, called *Back-rag*, and another of luſty white-wine, ſtanding in a room a ſtory high, expoſed to the ſaid wind, had moſt of the wine frozen in them; the ices whereof being taken out, taſted ſomewhat weaker than the wine itſelf. All the ſame things happened the ſixth night of the ſame month. It is to be obſerved, that the pint of claret, and the ſack in the tube, were both frozen throughout theſe two nights, and after their double freezing and thawing, they loſt nothing of their ſpirit, colour, and taſte; nay, the claret being a ſtrong *Burgundy* wine, though it often ſuffered glaciation and thawing for three weeks together, yet in all that time ſuffered no manifeſt alteration, but appeared the ſame to ſenſe, as when it was expoſed, in colour, taſte, and ſtrength.

As to the concentration of coloured liquors, Mr. *Hook* ſhewed me an oval glaſs, having at one end a narrow cane above an inch long, almoſt filled with water, tinged with cochineal, frozen; throughout, the ice round about, towards the ſides of the glaſs, ſhewed wholly colourleſs, but that in the midſt was of an exceeding high dye, but the ice, that was raiſed to the neck of the glaſs, was lightly tinged with a ſcarlet hue. Hereupon having ſome flaſks by me, I put into one a ſtrong decoction of cochineal, and into another a like decoction of ſoot, which being expoſed to the air, and incompaſſed in a veſſel with ſnow and ſalt, they did freeze to the thickneſs of an inch or more; and the air then beginning to relax, I broke the flaſks, and the diſſolved ice yielded a water totally colourleſs. I made alſo an experiment with a very ſtrong decoction of gentian roots, which being expoſed in a four-ounce phial, the ice thereof had a far deeper colour, and bitterer taſte in the middle, and towards the bottom, than towards the outſides of it.

And whereas *Barclay* relates, that King *James* being in *Denmark* to fetch his Queen thence, in the winter ſeaſon had his noſe and ears in danger of gangreening; which being timely perceived by ſome of the King of *Denmark*'s nobility, they cauſed the parts to be rubbed with ſnow, and ſo the danger was avoided; the ſame travellers affirm, that in the northern parts, where men become ſtiff with cold, and almoſt frozen to death, that they rub the frozen parts with ſnow, or elſe caſt the whole body into water, by which means the whole body is cruſted over with ice, as eggs and apples are, as if the freezing atoms did paſs from the body frozen into the water or ſnow; and this way of curing gangreens from cold, *Sennertus* doth preſcribe. To make ſome experiment hereof, I expoſed fleſh and fiſh, and found, that by immerſing them into water, they ſoon became more limber and flexible, and more eaſily yielding to the knife, and compaſſed with a cruſt of ice of the thickneſs of about half a crown, manifeſt tokens of their thawing; and being cut, they diſcovered nothing of ice in them. This, for more certainty, I often reiterated, as alſo in eggs and apples, above a dozen times, and never failed of unthawing them by this way. It is to be noted, if you immerſe the fleſh, fiſh, eggs, or apples deep into the water, no ice will appear on their outſides, but only when you hold them near the ſurface of the water.

As to the Perſian experiment mentioned by *Olearius*, of making huge heaps of ice to be preſerved for cooling of their drinks, I obſerved, that by pouring water into an open pan, or into a flaſk gradually, ſome at one time, ſome at another, I could quickly freeze by this way a whole flaſk-full, when near half of a flaſk filled at once, though helped by art, was unfrozen. I obſerved alſo, that the ditches between *Southwark* and *Rotherhith* had acquired an exceeding thickneſs of ice, cauſed by the flowing of the water in them at full tide; for new water being brought in by the tide, was there congealed to the thickneſs of ſome inches every ebbing and flowing. I obſerved alſo the ice on the banks of *Thames* above two yards thick; the inhabitants told me they had ſeen it three or four yards thick, which thus came to paſs: the tide flowing in, and meeting with great flakes of ice, drove them to the banks, and lodged them on the ice there frozen; which flakes uniting there with the former ice, raiſed it to that exceſſive height or thickneſs. Beſides, every one may obſerve in *London* ſtreets, and elſewhere, in channels, where no conſtant current is, that water coming from the houſes ſoon fill the channels with thick ice; for running but a little at a time, it freezeth almoſt as faſt as it cometh thither. Nay, I have ſeen ice of ſome yards thickneſs in ſuch places, where a ſmall rill or ſtream of water gently falls on the ſide of a hill.

Amongst thoſe things, that will freeze, mortar and plaiſter of *Paris* were omitted; and thence it is, that plaiſterers and bricklayers play all the winter.

My Lord *Verulam*, in his Natural Hiſtory, ſays (and ſome from him have affirmed to me) that apples and eggs covered with a wet cloth will not freeze, but I find no difference in thoſe, that are thus covered, and them that are not.

ADD to thoſe, that ſink upon congelation, all oils from animals, and from vegetables, that are extracted by expreſſion or boiling.

ADD to thoſe, that freeze not, water and ſugar boiled to the conſiſtence of a ſyrup, and alſo other ſyrups, none whereof I could ever take notice, or learn by others, that they would freeze. It is true, that water having an equal quantity of ſugar diſſolved in it, will freeze, but with a little more mixed therewith, freezeth not.

To try the effect of cold upon loadſtones, I expoſed ſeveral of them in the open air, and alſo within rooms, in the moſt ſevere weather, the needle being kept in a very warm place. At other times I expoſed the needle to the cold air, keeping the ſtones warm, at other times both were expoſed; but in none of my experiments could I conclude any thing certain as to their attractive faculty: for the ſphere of their activity was found to be ſometimes greater, and ſometimes leſs, to a conſiderable difference, in ten ſeveral good ſtones imployed for this purpoſe.

I ESSAYED alſo to find out a ſtandard of cold, whereby to fit the tinged ſpirit of wine for the weather-glaſſes, and to that end made uſe of conduit-water, and the diſtilled waters of plantane, poppies, black-cherry, night-ſhade, ſcurvigraſs, and horſe-radiſh; all which were firſt placed in the ſame room where a fire was kept, and then removed, and meaſured out into ſpoons in equal quantities, and alſo a drop of them dropped on the ſame bench: but though this was often tried, I could not make any ſure inference from them. Only I obſerved, that the black-cherry-water did for the moſt part freeze firſt, but the other with very great uncertainty. The horſe radiſh, and ſcurvigraſs-waters, were for the moſt part froze laſt. The beſt way to diſcover the very beginning of freezing of liquors, is to move a pin or needle through the liquors, whereby the ice will be raiſed, and become diſcernible, when the naked eye can diſcover none at all.

# AN APPENDIX, CONTAINING SOME Promiſcuous EXPERIMENTS and OBSERVATIONS Relating to the Preceding HISTORY of COLD.

### *Particulars referable to the* II^d^ *title.*

1. THE 26th of *December* in the morning, (being an extraordinary hard froſt) there appeared to be quite frozen in my window near the fire, a phial full of the ſolution of minium, [made in the ſpirit of vinegar] ſo ſtrong, that part of it was ſhot into ſaccharum Saturni: only at the top of them there was a little (leſs than a quarter of a ſpoonful) that looked yellow, and was not frozen, though, being poured out, it did not freeze like an oil.

2. A SOLUTION of gold, made with ſalts, and ſtanding in the ſame window by the ſolution of minium, was alſo frozen.

3. THERE was expoſed a pint phial full of the tincture of lignum nephriticum, which being frozen, there appeared no colour in the ice, when the phial was held from the light, as in the liquor before it was frozen.

4. THE often mentioned ingenious gentleman, Mr. *Drummond*, who was lieutenant-general of the Ruſſian army, told me, that he had divers times ſeen brandy frozen in *Ruſſia*, but the ice was not ſo hard as common ice.

5. A FRENCH ſurgeon, that waited upon an extraordinary ambaſſador to *Moſcow*, being inquired of by me about the freezing of ſpirit of wine, anſwered me, he had good ſtore of brandy frozen in the bottles, and that the unfrozen part, which was retired to the middle, was a ſpirit of wine by great odds ſtronger than ordinary brandy.

THE above-mentioned ambaſſador alſo told me, that it was uſual in their country to have wine freeze.

### *Paſſages taken out of a letter of the Ruſſian Emperor's phyſician to Mr.* Boyle.

6. THE 7th of *December*, I put ſome very ſtrong French brandy into a China cup, ſuch as they drink coffee out of, and expoſed it to the air: in three hours time it was turned into a cruſty ice all about the ſides of the cup, as if ſome cold blaſt had forced it abroad.

WATER and ſallad-oil were expoſed, the oil reduced to the firmneſs of tallow, the water not frozen.

### *Particulars referable to the* III^d^ *title.*

1. THE ſpirit of ſal armoniac made with quick-lime, volatile oil of amber, a ſmall quantity of oil of vitriol, ſolution of ſilver in aqua fortis, ſome diluted

with rain-water, and a phial full of weak *ſpiritus ſanguinis humani*, were expoſed two nights and a day to the cold. The event was, that the three former liquors appeared not to be at all frozen; the ſolution of ſilver was frozen, and the ſpirit of blood appeared almoſt totally turned into ice, (for ſomething ſeemed to be unfrozen at the bottom, eſpecially near the middle part of it) and the ice roſe up high enough to fill the neck, and thruſt out the cork, which I found lying upon the ice above the neck. (The glaſs was not hereby broken.)

2. UNRECTIFIED oil of turpentine, though being expoſed all night in a ſingle phial, it would not freeze; yet the ſame quantity (which was about two or three ſpoonfuls) being expoſed in an open earthen pottinger, the upper part afforded ice of a pretty thickneſs, and figured almoſt like that of frozen urine.

3. A TRAVELLER, bred to be a phyſician, informed me, that in that part of *Scotland*, where his father now lives, there is a lake, out of which runs a little river, whoſe waters, neither in the one, nor the other, are ever frozen in the midſt of winter (which in thoſe northern parts is wont to be very ſharp) and that lumps of ſnow and ice caſt into that lake do readily diſſolve there; and yet, as he anſwered me, this water doth not differ in taſte from common water, as he divers times obſerved.

4. I WAS told by a colonel, that the ſoldiers this winter making uſe of ſallad-oil to keep their locks from freezing, found they could not diſcharge; but being adviſed to hemp-oil, they froze not: neither will train-oil freeze, as it is told me.

### *Particulars referable to the* VI^th^ *title.*

1. LIEUTENANT *G. Drummond* told me, that he had often been fiſhing on ponds and lakes, that had been frozen over ſo ſtrongly, that men might march with cannon over the ice; and yet theſe lakes were ſtored with live fiſh, as they found, when they broke the ice in ſeveral places, and drew their nets under the ice from one hole to another. The fiſh being drawn out, and packed up in this ſtate, would continue good for a month, or better, without being either ſalted or dried.

2. AND it was remarkable, that the fiſhes being drawn out of the water found ſo great a difference between it and the cold air, that preſently after, as ſoon as they had made ſome few leaps up and down, they were in a trice frozen as ſtiff as boards. He told me, that fleſh and fiſh, if when it was frozen, it was thawed by the fire, would be quite ſpoiled, and the fleſh would not only loſe its natural taſte, but would be incredibly hard and tough. But fleſh and fiſh being kept in cold water, would there thaw, and become tender, and ſo grow fit to be dreſſed; yet he obſerved not, that in the thawing they acquired a coat of ice, as I told him I obſerved frozen eggs and apples do in *England*, when thawed in cold water.

3. HE alſo told me, he had frequently ſeen men to have the end of their noſes, and the upper part of their cheeks frozen, even when themſelves were not aware of it, and that they were very careful not to enter into a ſtove, or come near the fire, to relieve themſelves; becauſe if they did, the frozen parts would be apt to mortify, and come off, but they would rub them well with ſnow, by which means they were thawed, though not without ſome trouble, yet without danger.

4. IN *Lapland* they uſe another way to reſtore frozen limbs, *viz.* by making a certain kind of a cheeſe of deers milk, which they toaſt againſt the fire, and

anoint the place affected with the *Caws-boby*, and that reſtores the frozen member immediately.

5. I HAD ſome *Cheſhire* cheeſes, of which I deſired the cheeſemonger to chooſe the fatteſt and firmeſt to reſiſt the froſt; but they were all frozen, as alſo a *Chedder* cheeſe of a hundred pound. I threw one into cold water, and in a quarter of an hour it gathered ice about it, or rather the water extracted the icicles out of it.

6. FISH thaws ſooner and kindlier in cold water, than in the warm ſtove; but thawing in water is not ſo proper to fleſh, which muſt have a time anſwerable to its bulk, or elſe it will never roaſt further than it is thawed, roaſt it never ſo long, and carefully.

7. IT is their cuſtom in *Ruſſia*, eſpecially at *Moſcow*, to thaw their fiſh (before they put it to boil) by letting it lie in cold water, till it hath got a cake of ice about it, which they take off, and then put the fiſh into new cold water, and, when it is covered with ice, take it out again: this they continue to do, till the fiſh will occaſion no more ice, and unleſs this be firſt done, they find it will never be well boiled.

8. AN old ſea-captain told me, that they very often met with large white bears, out of which they had fat enough, when well ordered, to yield a hogſhead of oil.

THE ſame captain told me alſo, that white bears in or about *Greenland*, notwithſtanding the coldneſs of the climate, have an excellent ſcent; and that ſometimes, when the fiſhermen had diſmiſſed the carcaſs of a whale, and left it floating on the waves three or four leagues from the ſhore, from whence it could not be ſeen, theſe animals would ſtand as near the water as they could, and raiſing themſelves on their legs would loudly ſnuff in the air, and with the two paws of their fore-legs, as with fans, drive it as it were againſt their ſnouts; and when they were (as my relator ſuppoſed) ſatisfied whence the odour came, they would caſt themſelves into the ſea, and ſwim directly towards the whale, as my relator and others obſerve, who had the curioſity to row at a diſtance after them, to ſee whether their noſes would ſerve them for guides, when their eyes could not. He ſaw no other bears in thoſe parts but white ones.

9. AN inquiſitive doctor of my acquaintance bought at *Moſcow* a ſmall quantity of *Malaga* ſack, that did as it were drain out at the bottom of a pipe or hogſhead, that had not been tapped, till it was (unawares to the owner) frozen. This liquor was much ſtronger and better than the wine that afforded it, and the fame of its goodneſs making others croud to buy the remaining part of it, they found it, when the veſſel was kept in a warm place, which thawed the ice, to be little elſe than ſtrengthleſs phlegm. The ſame phyſician had likewiſe ſome ſtrong beer frozen, whereof the part that reſiſted the cold (and was taken up near the top of the veſſel) was ſtronger than wine; but the reſt, which had been once ice, was worth little or nothing. And as to theſe and the like glaciations, the ſame doctor told me, that he obſerved not the unfrozen liquor to retire always into the middle of the veſſel, but rather (eſpecially in ſack) to be intermingled with the ice, almoſt (as I gueſs by his deſcription) as honey is diſperſed into an honey-comb.

10. SOME of the men of the old ſea-captains, that had been in the frigid zone, being on ſhore off *Greenland*, opened a barrel of good beer ſtanding an end, and before they had drank much of it, the wind turning ſuddenly fair, and being haſtened aboard, they left the barrel behind them; and the next year coming again to the ſame place to fiſh for whales, ſome of them went aſhore in a ſhallop, but were by extreme cold, and the interpoſition of ſome ice, kept for a day or two from being

able to get to the ſhip; by which accident their proviſion falling ſhort, one of them remembred the barrel left behind, and coming to it, found it ſtanding where they left it, but very hard frozen; whereupon they took a ſpit they had with them, and made a good fire, and therein heating it red-hot, they broached the frozen barrel with it, and when the ſpit had reached almoſt the middle part of it, there came out ſome quarts of a turbid liquor, but ſo ſtrong and heady, that it made moſt of them drunk, and fall aſleep for divers hours: after which waking, they did for curioſity ſake ſtave the caſk, and found, that about this ſpirituous liquor the wateriſh part of the beer had been hard frozen on every ſide, and the liquor had been altogether incloſed in thick ice. This relation I had from the old captain himſelf, who was imployed in that voyage.

11. THE often mentioned governor of *Smolenſco*, a famous fortreſs between *Ruſſia* and *Poland*, told me, it often happened, that the French, and ſometimes the Spaniſh wines, that are yearly brought from *Archangel* to *Moſcow*, are ſo frozen by that time they come thither, that their owners are fain to break the caſk, and cleave the ice with hatchets, and then they tranſport it from place to place in ordinary jars, (ſo hard it is frozen) and when they mean to reduce it to liquor again, they put it into another caſk, and that caſk into a deep hole made into the ice or ſnow, where it will ſlowly thaw, and be far leſs impaired, than if it had been thawed by the fire-ſide, or in a ſtove.

## The Phænomena of an Experiment about Freezing, made by Mr. BOYLE, referable to the VIIth Title.

[This Paper was produced and read in the Royal Society, *Nov.* 23, 1671.]

WE took a bolt-glaſs, bigger than two turky-eggs, with a ſtem, which we cauſed to be drawn out at a lamp, till it was as ſlender as a gooſe-quill, or thereabouts. This veſſel was filled with water, till the liquor reached to a pretty height in the ſlender part of the ſtem. Then I put it into a mixture of beaten ice and ſalt, in which mixture a cavity had been before made to receive a good part of it. But though upon our putting the glaſs into this cavity, there would at the very top ſeem to be ſome little ſhrinking down of the water, yet that was very ſmall, and ſometimes very ſcarcely, if at all, diſcernable; nor did the water afterwards appear to ſubſide, and exhibit the other phænomena of freezing water mentioned by the excellent Florentine virtuoſi: only when the liquor began below to be turned into ice, the quick aſcent of it was manifeſt enough.

WHEREFORE we afterward cauſed the ſtem of a round bolt-head of clear glaſs, whoſe globous part was about 3½ inches in diameter (taken on the out-ſide with calliper compaſſes) we cauſed, I ſay, this ſtem to be drawn out at the flame of a lamp, till it was at leaſt as ſlender as a raven's quill; and the glaſs being filled with water to a competent height, that the expanſions and dilatations of it might be very manifeſt in ſo very ſlender a pipe, we obſerved the enſuing phænomena.

FIRST, As ſoon as the globous part of the glaſs came to be as it were immerſed in the frigorifick mixture, the water in the ſmall ſtem inſtantly aſcended, ſometimes the length of a barley-corn, and ſometimes leſs, and ſometimes more. And this aſcenſion was ſo haſtily made, that it often begun and ceſed almoſt in the ſame moment;

after which the water began (though more ſlowly) to ſubſide again to its former ſtation, or thereabout, which, with other circumſtances, made it very probable, that as the Florentine virtuoſi ingeniouſly labour to prove, this ſudden change proceeded rather from the conſtriction of the glaſs it ſelf upon the firſt contact of the frigorifick mixture, than upon the ſenſible condenſation of the water, which is not likely to be ſo ſuddenly effected.

SECONDLY, But whereas the newly named philoſophers recite, as a conſtant phænomenon, that after the firſt ſubſidence of the water, and a ſubſequent pauſe for a pretty while, the water will be conſiderably depreſſed once more, before it begins to riſe, we could very rarely indeed and ſcarce ever obſerve ſuch a thing to happen, though I cannot ſuſpect myſelf to have overſeen it for want of attention. For my expectation of ſuch a ſubſidence of the water, and its not appearing to me the firſt and ſecond time, invited me to repeat the experiment ſeveral times one after another, and to look very attentively upon the water, and the marks carefully ſtuck on the ſide of the glaſs, to obſerve the motion of the liquor. And this ſeemed the rather ſtrange to me, becauſe I had often formerly obſerved in trials purpoſely made on other occaſions, that water in convenient glaſſes would ſuffer ſome degree of condenſation by the action of a frigorifick mixture, before it would begin to diſcover any ice in it. But having reiterated the experiment, till I, and thoſe that aſſiſted me, grew weary, I was fain to abandon it, leaving the proſecution of it to farther trials. For I dare not ſuſpect, that ſo many eminent virtuoſi, as ennoble the Florentine academy, could miſtake, or miſrelate a matter of fact, not once, but frequently, and uniformly taken notice of by them. And beſides that, as I was ſaying, it is conſonant to my own experiments on other occaſions, in one of the glaſſes, wherein I tried this very experiment, I obſerved the ſecond ſubſidence to be conſiderable. So that I cannot but ſuſpect, that the ſo differing events of their trials and mine, as to this phænomenon, may proceed either from ſome peculiarity in the water they employed, or in the qualities of the glaſs, which the veſſels I uſed were made of, or in the length and ſlenderneſs of the ſtem, conſidered together with the groſſneſs of our Engliſh air in ſnowy weather, the preſſure of the air having elſewhere been ſhewn by me to have a great ſtroke in divers condenſations aſcribed to cold: but whether to any of theſe things, or any other, that, which we have related, is to be reduced, future trial muſt determine.

THIRDLY, I obſerved for the moſt part, that after that ſubſidence, that almoſt immediately attends the firſt riſing of the water, there would be for ſome time, more or leſs, a reſting of the ſurface of the water in the ſame place, which continued till the upper part of the water began to aſcend upon the beginning of the glaciation of its lower parts; and the duration of this pauſe or reſt of the water I found to be very uncertain, being at ſome times at leaſt twice or thrice as long as at other times, according as the frigorifick mixture did more or leſs vigorouſly operate upon the neighbouring water.

FOURTHLY, Though if the experiment was tried in glaſſes, whoſe ſtems were of an unuſual bigneſs, the aſcenſion of the water in the ſtem upon the glaciation of it in the globous part, was not ſo quick as to be very remarkable; yet when the ſtem was drawn out to ſuch a ſlenderneſs, as was before deſcribed, the water, after having (as I lately noted) reſted a while, would, upon its beginning to freeze beneath, aſcend ſo haſtily in the ſtem, as appeared ſtrange enough, eſpecially at the firſt ſight: ſo that uſually its progreſs upwards was very obvious, and ſometimes made with ſuch celerity, that in one minute of an hour, or much leſs, it would as it were ſhoot up ſeveral inches, and would have probably aſcended much higher within half a minute more, if the ſlender part of the ſtem had been long enough to permit it.

FIFTHLY, But whereas the Florentine academicians inform, that there is a conſiderable intumeſcence or riſing of the water, that does immediately precede glaciation, I never could ſatisfy my ſelf, that I obſerved ſuch a phænomenon. But in ſpite of frequently repeated trials (both alone, and before others) and of ſuch a degree of attention as perhaps is not often imployed even in more nice trials, it always appeared to me, that the aſcenſion of the water was at leaſt accompanied, if not rather preceded, by the actual glaciation of ſome parts of the water, that were moſt contiguous to the frigorifick mixture, or expoſed to thoſe portions of that mixture which were the moſt operative. Nor did it ſeem eaſy to me to aſſign any other, or at leaſt, better reaſon of the aſcenſion of the water in the ſlender ſtem, than the expanſion, that is wont to accrue to water, upon its being actually turned to ice. It is true, that in ſlender ſtems the riſing of the water will be manifeſt upon the production of ſo thin and tranſparent films of ice at the bottom, or ſome of the lateral parts of the globe the water is contained in, that it has often deceived even attentive eyes, and would have deceived me too, if the newly intimated conjecture at the reaſon of the intumeſcence of the water had not made me extraordinarily ſuſpicious, and invited me to look upon the glaſs taken out of the frigorific mixture (and then wiped and held againſt the light) in ſo many differing poſtures, that though in ſome of them I could not, yet in others I did diſcover thin portions of ice, which ſometimes I could within a minute or leſs make viſible to others; becauſe this ice upon thawing would not unfrequently emerge to the confines of the globe and ſtem, and there become eaſily enough diſcernible to a heedful eye. And though when I gueſſed, that the water was upon the point of beginning to freeze, I took it out of the frigorifick mixture, to try if it would afterwards freeze, or make the liquor in the ſlender pipe aſcend; yet I never was ſo fortunate, as to obſerve any aſcenſion of the water in the ſtem, but when there was actually ſome particles of ice in the ball, which though I newly took out of the mixture, as ſoon as I could perceive the leaſt beginning of riſing in the ſlender part of the ſtem, yet I regularly found more or leſs ice to have been already actually produced at the bottom or ſides of the globe. The aſcenſion of bubbles about the time of the water's congelation (eſpecially if the glaſs were ſtirred) I do not here ſolemnly take notice of, it being an uſual concomitant of the glaciation of water.

SIXTHLY, It was remarkable, and not unpleaſant in our experiment, that not only if the glaſs were taken out of the mixture, very ſoon after the water began to aſcend in the ſtem, the thaw, by reaſon of the extraordinary thinneſs of the ice, would begin ſo quickly, that within about half a minute, or ſometimes much leſs, the liquor would begin to ſubſide manifeſtly again. But when the water was ſufficiently diſpoſed to congelation, which it uſually was, if the glaſs were put into the frigorifick mixture ſoon enough, after the total diſſolutions of the little portions of ice newly mentioned, it would, upon the contact of the frigorifick mixture, though the globe were but half buried in it, begin to glaciate in a trice: inſomuch that making obſervation by a minute watch, I have had the water ſhoot up in the ſtem within half a minute, ſo as to diſcover ice in it, and within two minutes (from firſt to laſt) to exhibit ice in moſt parts of the cavity of the globe.

### *Particulars referable to the* VIII^th^ *Title.*

1. TWO ſealed weather-glaſſes, one with ſpirit of wine, and cochineal, the other with a blue liquor made with ſpirit of man's blood, copper, and ſpirit of wine, were immerſed in water, and kept there, till the glaſs, that contained the water, began to diſcover ſome ice within it: then, this water being thrown out, theſe thermometers were removed into oil of turpentine, (ſubſtituted for the water of the ſame veſſel) and ſnow and ſalt being applied to the outſide, the oil of turpentine (whoſe freezing in ſuch a quantity and veſſel we were not afraid of) was made as cold as we could. Whereupon the liquor in both the weather-glaſſes manifeſtly and conſiderably ſubſided beneath the former mark, and in one of them (which had the blue liquor) though it were but a ſhort one, the ſubſidence was made half an inch; which ſtill confirms, that the air may impart a higher degree of cold than is neceſſary to make water freeze, and than is always communicated by ice it ſelf.

2. THE eſſential oils, as Spagyriſts call them, that are made of ſpices, and other ſpirituous materials by diſtillation in water, being, by reaſon of ſpirituouſneſs, unapt to freeze; men could not obſerve, what effect a degree of cold capable of coagulating them would produce, in reference to their taking up more or leſs room, when congealed, than when fluid: ſome liquors having been found by experience to be expanded, others to be condenſed, by being made to congeal or to concrete by cold. Wherefore conſidering, that oil of aniſeed, though an eſſential oil, will loſe its fluidity, not only ſooner than hot liquors, but with a far leſs degree of cold than water it ſelf, I thought this would be a fit ſubject to make trial upon; and accordingly having put a convenient quantity of this liquor into a round glaſs, about the bigneſs of a middle-ſize orange, furniſhed with a ſuitable ſtem, we put a mark, where the ſurface of the liquor reſted, at about five inches above the ball. Then putting the glaſs into a veſſel of water, made cold by powdered ſal armoniack put to diſſolve in it, we obſerved, that the oil in the ſtem ſubſiding did grow whitiſh, though by inclining the glaſs it was eaſy to diſcern, what part was yet fluid. In a ſhort time after this the oil ſeemed totally coagulated into an opacous and very white body, (almoſt like ſperma ceti) whoſe upper ſurface was near three inches beneath the mark formerly mentioned; ſo that the liquor appeared to have been not inconſiderably condenſed by the operation of the cold. Which further appeared by this, that whereas the oil of aniſeeds, whilſt fluid, would ſwim upon water, this butter-like concretion would ſink in it. And yet when I watched, I could obſerve, that upon the ſlow thawing of this thickned ſubſtance, there emerged from time to time ſeveral bubbles into the already fluid parts, divers of which bubbles might plainly be ſeen in the coagulated matter before their emerſion; juſt before which ſeveral of them exhibited various and vivid colours, and very pleaſant to behold.

### *Particulars referable to the* X^th^ *Title.*

1. A FLAT bolt-head, ſealed up with a ſtem about 17 inches in length above the ſuperficies of the water, being ſet in the frigorifick mixture for eight or nine hours, the water aſcended 15 inches and $\frac{1}{2}$, that I meaſured, and afterwards $\frac{1}{8}$ or $\frac{1}{4}$ of an inch, according to the meaſure of another; after which time neglecting it for one hour or more, while I was at ſupper, it blew off the ſealed end of the glaſs quite round, and broke the bottom of it into many pieces, leaving almoſt all the whole body of the pipe uncracked.

2. WATER freed from air, by ſtanding a good while in the exhauſted receiver, being ſealed up in a round bolt-head, whoſe pipe above the water was five inches or

a little more to the ſealed apex, being ſet in a frigorifick mixture, exhibited an ice very prettily ſhaped, and without conſpicuous bubbles; in leſs than two hours the water came to be impelled up four inches and $\frac{5}{8}$, and ſeemed to reach a little above the baſis of the conical and ſealed part; upon its breaking with a noiſe, the pipe was entire, and there appeared a good part of the water unfrozen under the ice, and the broken veſſel ſeemed to ſmoke. Upon conſidering the ſhortneſs of the conical part of the glaſs, we gueſſed the air to have been compreſſed to about the 20th part of its former room.

3. THE globulous part of a glaſs-egg of about three inches (for it wanted $\frac{1}{10}$) in diameter on the out-ſide, was filled with water to the bottom of the ſtem, and then being carefully freed and ſealed, was frozen from the bottom upwards, to try, whether the abſence of the formerly incumbent air would not make the ice afford larger bubbles, and conſequently take up more room, than otherwiſe it would, when the water was frozen in the ball; and a little way in the lower part of the ſtem we found, that (the remaining) water reached from the firſt ſtation of the water about eight inches and $\frac{1}{2}$, the length of the whole ſtem being a very little more than ten inches and $\frac{1}{2}$. Being afterwards ſealed up with air in it, and frozen, the ice reached not in it full four inches above the firſt ſtation, though (if I miſtake not) it was as well frozen this time as the former.

### *Particulars referable to the* XI<sup>th</sup> *Title.*

1. THERE was taken a ſtrong cylinder of braſs, whoſe cavity was two inches in diameter, into which was put a bladder of a convenient ſize, with a quantity of water in it, that the neck of the bladder (which I had taken care to have oiled) being ſtrongly tied, the water might not get out into the cavity of the cylinder, nor be capable of expanding it ſelf any other way than upwards. Then into this cylinder was fitted a plug of wood turned on purpoſe, which was ſomewhat leſs in diameter than the cylindrical cavity, that it might riſe and fall eaſily in it. Upon the upper part of this plug was laid a conveniently ſhaped flat body, upon which were placed divers weights to depreſs the plug, and hinder its being lifted up by the expanſion wont to be made in water that is made to freeze: then a frigorifick mixture being afterwards applied to the cylinder, it appeared within half an hour, or ſomewhat more, by a circle, that had been purpoſely traced on that ſide of the plug, where it was almoſt contiguous to the orifice of the cylinder, that the water in the bladder began to expand it ſelf; and about two hours after having occaſion to ſhew the experiment to ſome inquiſitive perſons, the circle appeared to have been heaved up, in my eſtimate about $\frac{3}{8}$, if not half an inch, notwithſtanding all the weights, that indeavoured to hinder the aſcenſion, though theſe weights amounted to 115 pound; which were all the determinate weights we could then procure, beſides brick, and ſome other things, that were eſtimated at five pounds more. Nor did I doubt, that a far greater load would not have hindered its expanſion.

THE day after the above-mentioned experiment was made, to try the expanſive force of freezing water, the ſame was reiterated after the manner above delivered, but with this difference, that having procured more weights, when the plug was lifted up $\frac{2}{8}$ of an inch, or ſomewhat better, (which plug began ſenſibly to riſe within half, or three quarters of an hour, after the frigorifick mixture was applied) it was loaded with a weight of two hundred pounds, and a fifteen pound piece of lead, and other bodies, as boards, &c. to lay the weights upon; which being alſo weighed by themſelves, came to fifteen pounds more, ſo that the whole amounted to 230 pounds: and if the hundred pounds were both of them (as their bulk and weight invited us to gueſs) of that ſort of weights, which are called the great, a hundred containing a hundred and twelve pounds apiece, twenty four pounds muſt be added to the ſum, which would thereby be made up 254 pounds.

2. An iron barrel, being about 14 inches long, and having about $\frac{3}{8}$ of an inch diameter at the bore, and where the greateſt thickneſs of the metal was $\frac{3}{16}$, and the leaſt $\frac{2}{16}$, or ſomewhat better, being exactly ſtopped at the breech, and having a ſcrew of a convenient length to ſtop it at the other end, was filled with water, and then the ſcrew being put in, the barrel was buried in a mixture of beaten ice and ſalt for about two hours or longer; at the end of which time being taken out, it appeared to have a crack running ſomewhat oblique, by beginning at a place about three inches diſtant from the breech, and reaching to ſomewhat above ſix inches from the ſame: the crack was much more wide and gaping towards the middle of the barrel, which appeared alſo diſtended about that part; the ice being taken out in divers pieces, and held againſt a candle, ſeemed to have ſmaller bubbles than it would have had, if the water had not been pent up. But the minute bubbles were ſo numerous, that they made the ice more than ordinarily opacous.

3. A strong barrel of a gun of twenty four inches long, having the touch-hole ſtopt, and a plug of iron, that was fitted to the muzzel, forcibly driven in, after the barrel had been filled with water, was put into a mixture of ice and ſalt, where within about three minutes by my watch, the lately named plug was with noiſe driven out of the end it had cloſed before; and when the ſame plug was afterward ſo driven in, that, to make the cloſure more perfect, the ſides of the orifice of the barrel were hammered down upon the outward end of the plug, yet, within about three minutes more, the frigorifick mixture making the water expand it ſelf, made it again drive out the plug, and that not only with noiſe, but with ſuch violence, that we found it had broken a deal-board, that made the neareſt part of an oblong box, (wherein the operation was performed.) Afterwards the iron plug being by the help of the fire and a hammer as it were incorporated into the barrel, the touch-hole came to be unſtopped; and though a long iron nail was ſtrongly driven into it, yet the plug being uncapable to be driven out (as before) the frigorifick mixture being again applied to the barrel, quickly drove out the nail; which, laſtly, being again forced in, and the commiſſure being for farther ſecurity brazed over, there was now no room left for the included water to expand it ſelf much, but by breaking the barrel. But being my ſelf called away, ſo that I could not ſtay to ſee the iſſue of the experiment, I left one to proſecute it, who ſoon after brought me an account, that within about a quarter of an hour (by his gueſs) after the barrel was put into the frigorifick mixture, though of that there was ſcarce left enough to cover it, it burſt with a noiſe, and blew up the cover of the box (wherein the experiment was made) and the crack, which was two inches and a half long, was wide and gaping enough to let me ſee, that the barrel was of a very conſiderable thickneſs at the place, where it was broken.

A new pewter bottle, holding (by gueſs) about a pint, was filled with water, and then the top being ſcrewed on, was put into a frigorifick mixture, wherein when it had lain (by our eſtimate) about $\frac{3}{4}$ of an hour, it was broken, not without noiſe; and being taken out, we found in it a crack almoſt an inch and half long, and in one place ſo broad as to amount to about $\frac{1}{8}$ of an inch. The bottle ſeemed to be every way diſtended, and particularly at the bottom, which was ſo ſwelled, that the bottle would not ſtand upright upon it.

### *One particular referable to the* XIII^th^ *Title.*

THE old ſea-captain told me, that out at ſea, when the wind blew off from the great banks and tracts of ice, they could, by the extraordinary highneſs of the cold, (which would ſometimes make the ſkin of their faces peel off) perceive, which way the ice lay, not only long before they could ſee it, but ſometimes when they were fain to ſail twenty leagues, before they could come to it.

### *Particulars referable to the* XV^th^ *Title.*

1. THREE decoctions, one of ſage, another of roſemary, and the third of parſley, were expoſed in three ſmall earthen pipkins to freeze, and were totally turned into ice, without any uncongealed liquor (that I could perceive) in the midſt: nor did there appear in the ice any reſemblance of the decocted plants, but the ice afforded by the decoction of ſage had a very uneven ſuperficies, and far more rugged than the two other portions of ice, which were neither of them ſmooth; and theſe (eſpecially that of the ſage) were obſerved manifeſtly to be leſs hard or ſolid than common ice.

2. NEWLY expreſſed juice of lemons being ſet to freeze in a wide-mouth-glaſs, afforded an ice very oddly figured, eſpecially in one part, where it finely repreſented trees, as they are in winter, without leaves.

3. HARD ice groſly beaten, having a great proportion of white table-ſalt put to it, and mingled with it, there aroſe from the mixture great ſtore of whitiſh fumes, as thick (at leaſt) as common ſmoke, which fumes played up and down all the mixture, and laſted a very conſiderable while; and all this, though the weather was very warm, and the experiment made in a room, where there was a very good fire.

4. SNOW-water being put to freeze in ice and ſalt, afforded an ice prettily figured, and had the bubbles produced in it ſo minute, that they hindered not the globe, which the ice conſtituted, from being more tranſparent, than would have been eaſily expected.

5. WE took a quantity (not inconſiderable) of ice, about two pound or more, and having partly reduced it into ſmall lumps, and partly beaten it into ſmall powder, we mixt with it a convenient proportion of bay-ſalt not powdered. This mixture, when it was ſuffered to lie ſtill for a pretty while, did not appear to emit any thing from the ſuperficial parts; but yet afterwards, when it came to be ſtirred here or there, there would in that part ariſe a ſmoke eaſy enough to be diſcerned, if the baſon or platter, that contained the mixture, were held between the eye and the light. But if the whole body were ſtirred, then there would be excited ſo viſible a ſmoke, as that it would not only overſpread the ſurface of the veſſel like a miſt, but would overflow it on all ſides for a good while. I uſe the word, *overflow*, becauſe indeed the fumes did not only ſome of them aſcend a pretty way into the air like ſmoke, but the greateſt part of them by far, as ſoon as they were riſen above the brims of the veſſel, did fall down in ſtreams, as if it had been a liquor poured out of a baſon: ſo that the fumes ſeemed ponderous, almoſt like thoſe, that one may obſerve, if he dip a piece of linnen in aqua fortis, and hang it up to dry; in which caſe the emitted ſteams will rather fall than riſe. We alſo took notice, that thoſe ſteams of our frigorifick mixture were far more plentiful than they ſeemed to be; for beſides thoſe, that were manifeſtly ſpilt out of the brims of the veſſel, it was eaſy, by looking upon the mixture in a certain poſition in reſpect of the light; it was eaſy, I ſay, to perceive, that the whole cavity of the veſſel, which was pretty deep, was all covered with thoſe

fumes, that played upon it like thick miſt upon a pond, not being able to paſs over the brims of the baſon. And this aſcenſion of fumes, upon the ſtirring to and fro of the mixture, laſted a conſiderable while, and probably would have laſted longer, if partly wearineſs, and partly buſineſs, had not called me away.

I FORGOT to note, that when thoſe ſteams came out the moſt plentifully, I applied my face to them, to obſerve, if I could feel them ſenſibly colder than the neighbouring air; but by reaſon of an impediment, I could not continue in a fit poſture long enough to be ſure, whether thoſe effluvia would in due time feel ſenſibly cold or no. And though I applied a ſealed weather-glaſs to the ſame fumes, and the tincted ſpirit ſeemed thereupon a little to ſubſide, yet ſome circumſtances make me ἐπέχειν till further trial.

6. THE old ſea-captain, that ſailed ſo often into the frigid zone, anſwered me, that when his ſhip was immured with ice, ſo that they could not in a long time get ſo much as a barrel of ſalt water, he made wells of the thick pieces of ice, to receive the liquor of the thawed ice, and found that water (though on the main ſea) to be good freſh water, potable, and fit for dreſſing of their meat, and other uſes, ſo that he never feared want of freſh water in thoſe ſeas.

HE alſo told me, that he had divers times faſtened the ſhip to the pieces of ice, that reached under water to about 30 fathom, and that once he lay a good while by a piece of ice ſo thick, that it was on ground at fifty fathom, which he clearly perceived, both by ſounding, and other ways of obſerving, that he acquainted me with. Theſe deep pieces of ice (he ſaid) were not very high above the water, inſomuch that when I told him I had found by trial, that a cylinder of our *Engliſh* ice could have but about the tenth part of it above the water it was made of, and made to float in, he anſwered, that that proportion agreed well enough with his obſervation: and added, that the great depth of the ice proceeded from the ſucceſſive ſnows, which, falling from the ſurface of it, depreſs it, and often within two or three days would itſelf melt, ſo as to ſhrink into a third or fourth part of its former thickneſs, and become hard ice. He likewiſe told me, that he had ſailed to 82 degrees and a half of latitude, and anſwered me, that he was not miſtaken in obſerving it, having had very good opportunity to do it by more than ordinary fit inſtruments, that he had carried along with him.

HE told me too, that in ſome parts near the coaſt of *Greenland*, he found the variation of the compaſs to be 22 degrees, and not very long after to be ſcarce any at all; which ſtrange alteration he knew not what to make of.

HE told me moreover, that the laſt year ſailing in the height of 77 degrees in the main ſea, he was ſuddenly ſurrounded, and his ſhip locked faſt up, only that it was driven by and with the ice, till the 7th of *June* following; and then, the ice opening a little, he made a ſhift to ſteer through it, and purſue his voyage; adding, that he obſerved, that that vaſt tract of ice being once broken, the fragments of it drove towards *Hudſon*'s *Streights*.

7. THE old ſea-captain told me as ſtrange a thing, which he had often, though not carefully obſerved, that great tracts of ice dead the wind; inſomuch, that when he has been driven towards the ice by ſtormy weather, and feared to be in great danger, when they came near it, he unexpectedly found a kind of calm, that raiſed his wonder, and freed him from his fear. And at other times going out of the ice upon an almoſt ſmooth ſea, when he had not yet gone far on it, he found, that there was a ſtorm at diſtance from the ice: and mentioning this, as a very odd thing, to a *Dutch* navigator, who frequented thoſe ſeas for the whale-fiſhing, he aſſured him, that he had ſeveral times obſerved this wonderful property of the ice.

### *One particular referable to the* XVII^th^ *Title.*

IN *Siberia* (a northern province of *Ruſſia)* the earth is thawed in ſummer but about two foot in depth, beneath which it continues frozen, and yet over this frozen part of the ground there groweth good corn. This I had from the *Ruſſian* emperor's chief phyſician.

### *Particulars referable to the* XVIII^th^ *Title.*

THE little ſealed weather-glaſs being taken, was put into a glaſs broader at the top than the bottom, and greaſed on the inſide with tallow, in which glaſs the ball in the inſide of it was more than covered with water; and that water being frozen, notice was taken whereabouts the tincted ſpirit of wine reſted in the ſtem: after which, the ice being newly taken off from the ball in the open air of an exceeding froſty morning, juſt upon the removal of the ice the liquor roſe a little in the ſhank, as it uſeth to happen, when a glaſs-bubble filled with warm water is ſuddenly removed into cold: but preſently after the tincted liquor, as I expected, ſubſided, not only as much as it had riſen, but a pretty way (the ſhortneſs of the inſtrument conſidered) below the former mark. Which may confirm our obſervation, that the free air may communicate a more intenſe degree of cold than ice itſelf.

2. THE weather having continued for ſome time very cold, we placed two or three days ago a truſty ſealed thermoſcope (that was made by the ſtandard weather-glaſs at *Greſham* college, which I therefore call the ſtandard thermoſcope, having uſed it for ſome years) in a cellar, where we had obſerved beer not to freeze in a very extraordinary ſharp winter; and having looked upon it laſt night, which was, as the night preceding, very froſty, the wind being at eaſt, we found, after ten a clock, that the tincted ſpirit of wine ſtood at two diviſions, and at $\frac{1}{8}$ above the freezing mark; and this morning being a hard froſt, it was found to ſtand much at the ſame height. Wherefore having cauſed it to be removed into the free air in the garden, it now being about nine of the clock, is fallen to the freezing mark, and conſequently is ſubſided above two full diviſions or inches beneath its ſtation in the warm cellar. But nevertheleſs I hence obſerve, that the air in the cellar, notwithſtanding the cold weather, is not (or is but very little) warmer than the air in my bed-chamber is wont to be in froſty weather: for the ſame weather-glaſs being uſually kept in that chamber, the ſpirit of wine was wont to ſtand about two inches above the cipher or freezing-mark, in the morning before the fire was made, in caſe there was a moderate froſt abroad; and in ſummer-time, when the weather was very hot, the tincted ſpirit has aſcended to the eighth, ninth, and ſometimes almoſt to the tenth mark.

3. THE laſt night being made extraordinary cold by froſt, ſnow and wind, the ſtandard weather-glaſs (before mentioned) was removed into the garden, and left there till this morning, when the tincted ſpirit appeared to be ſubſided above two diviſions beneath the cipher or freezing-mark; ſo much greater was the cold of the air, than was abſolutely neceſſary for the congelation of water. And yet the coldneſs of this very night did not by 'Αντιπερίστασις ſo increaſe the heat of the cellar, but that a phial, containing about two or three ounces of chymical oil of aniſe-ſeeds, being left there till nine of the clock this morning, was taken out without being thawed into a liquor: which argues, that the heat of the cellar was inferiour to that of the outward air in moderate ſeaſons, ſince oftentimes, both in ſpring and autumn, oil of aniſe-ſeeds is by the warmth of the air kept in a fluid form: as this particular parcel of

oil in the ſame phial, wherein it was expoſed, was kept by the moderate warmth of my chamber many times this winter.

4. This morning (being *December* 29, 1665) a little before ten of the clock, the weather having been froſty (bating one mild, but rainy day) for near a fortnight, I took my ſealed weather-glaſs out of my chamber-window, and having held it a while in the open air in the court, as alſo wetted it with water, to reduce it the ſooner to the coldneſs of the ambient air, I cauſed one to pump ſo long, till to a younger eye than mine, the water, that came out of the pump, ſeemed to begin to reek; and then I held the ball of the weather-glaſs for a pretty while in the ſtream, that came out of the pump, and obſerved, that it made the tincted liquor conſiderably riſe; and the more, the longer I kept it, till it was riſen to the height of the croſs, which I made in the frame. Then carrying it up to my chamber, though there was a good fire there, the ſpirit of wine began to ſubſide again; thereby ſhewing, that the air in my chamber was colder than the reeking water, that had been pumped out.

5. Another time (being *Feb.* 17, 166$\frac{5}{6}$) after it had continued froſty weather three or four days, (if I miſtake not the number) about nine or ten of the clock in the morning, I cauſed the water of a conſiderably deep well to be pumped for a good while upon it, after it had been kept a pretty while in the air, to bring it to the temper of that; the pump-water raiſed it by degrees, but ſlowly enough, to between four or five eighths of an inch higher than the pump-water at *Oxford* had been able to do. Then I carried the weather-glaſs to a ſpring, that was wont to ſmoke in froſty weather, and was not far from the pump; and having laid down the weather-glaſs, (that my hand might have no operation upon it) ſo as the ball was covered with water juſt at the ſpring-head; after it had reſted there a good while, I found the tincted ſpirit but very little raiſed: ſo that in all it ſcarce exceeded five eighths above the height it had been brought to at *Oxford*.

Afterwards in the ſame place I brought the weather-glaſs about noon to the north ſide of the houſe, to which the pump belongs; and letting it reſt againſt the wall in the open air for half an hour or more, I found, that though it had been that morning a ſmall froſt, and though the ſun did not ſhine out, yet by the weather-glaſs the air was juſt at the ſame degree of warmth (if not a little greater) that the water had been at the ſpring-head in froſty weather, when there was ſnow upon the ground; and conſequently the air was then much hotter than the water had been in the pump at *Oxford*, where yet in very cold weather it uſes to ſmoke.

*Feb.* 19, being the third day of the continuance of a moderate froſt, I held the ſealed weather-glaſs under the pump, and having cauſed the water to be pumped for a good while upon the ball of it, I found the tincted ſpirit riſe as high with the warmth of the water, as it had done many weeks before in the depth of winter, by the warmth of the water of the ſame pump.

The next day, being the fourth day of the froſt, the neighbouring ſpring, which (as I was informed by thoſe I ſent to ſee) had not, during the precedent days, ſmoked, did ſmoke this morning, as one I ſent to ſee, informed me, that another ſpring likewiſe did. About noon (the weather being fair, and the ſun ſhining) I employed one to keep the ball of the weather-glaſs for a competent time covered with water juſt at the head of the ſpring, which had ſmoked in the morning; and by his relation, which was confirmed by the height of the tincted liquor, when I ſaw it, it appeared to have riſen higher now by near or a full quarter of an inch, than I could make it do at the ſame ſpring-head divers weeks ago. But note, that this day the ſpring-water was a pretty deal warmer than the air, notwithſtanding the time and clearneſs of the day, as appeared by the ſubſiding of the tincted ſpirit, when brought from the ſpring to my chamber in a froſty morning, the ground being then covered (but not thickly) with ſnow.

6. HAVING inquired of an ingenious man, obliged to make ſome trials about cold, whether he had obſerved any thing to confirm or contradict the ſuſpicion I publiſhed in the Hiſtory of Cold about the coldneſs and temperature of the air; he gave me ſuch an anſwer, that does notably confirm my conjecture. For he told me, that he had divers times obſerved in an exactly ſealed weather-glaſs, that the tinged ſpirit of wine was higher at ſome times, when the weather was froſty, than at ſome other times, when it was not; and that having had occaſion to keep his weather-glaſs with the ball in water, which was afterwards frozen, and continued ice for divers days, he warily brake the ice all about the ball, and removing it thence into the air, though it were in the ſame room, yet he found the liquor to deſcend from ſuch a mark to ſuch a mark; and having deſired to ſee the inſtruments, I found the bigneſs of the ball to be like that of a middle-ſized or ſomewhat large crab, and the ſtem to be about two foot and a half long: and having had the curioſity to meaſure the diſtance between the above mentioned marks, I found, that the liquor, by being removed out of the ice into the air, had ſubſided a pretty deal above three inches.

*A relation given me by an ingenious gentleman, lately returned out of* Poland.

7. ABOUT the 21, 22, and 23d of *December* 1669, old ſtyle, lying within three *Poliſh* miles of *Warſaw*, we ſaw every day the ſun accompanied with two parhelions, the one eaſtward, the other weſtward, almoſt in a direct line, and diſtant about 8 or 10 times the diameter of the ſun from it, and continued viſible from near ten to twelve a clock, the weather being extreme cold, the air as clear, as poſſibly to be imagined, both night and day; and when the ſun did ſhine, appeared as full of glittering ſpangles or particles of ice. The like hath been ſince, when it hath frozen very hard; which generally happens, the air being very clear, and as generally thaws, the heavens being clouded any time together.

8. THE old ſea-captain, that ſailed ſo often to *Greenland* to fiſh for whales, aſſured me yeſterday, being *April* 8, 75. that 18 or 19 years ago, he ſailed thither in the company of two *Dutch* ſhips, whereof one was a *Hollander*, but the other of *Embden:* the names of the maſters he told me. When they were come together as far as the place, where the *Engliſh* uſed to ſtay in *Greenland* (as I remember) the maſters of the two ſhips deſired this captain to give them leave to fiſh there with him; which, he told them, he could not poſſibly do, being a ſervant of the *Greenland* company, and employed there by them. Whereupon theſe maſters told him, that they would then go ſeek their fortunes in an unknown world; and ſeven or eight weeks after, they came back to him, miſerably diſtreſſed for want of freſh water and fewel, which they deſired his leave to take upon the place; which being but an act of humanity and intrenched not upon the rights of the company, he willingly permitted. Whereupon they fell into diſcourſe of their voyage; one of the maſters told him, that coaſting along the ice, in hopes to find ſome new land, and ſome place where they might freely, as well as conveniently fiſh for whales, they had at length come ſo far, that after the foggy and dark weather was cleared up, they took the latitude, and found it to be 89 degrees, ſo that they were within one degree of the pole.

THE old captain doubting of this the maſter brought him his journal, where the courſe was ſet down, which teſtified the ſame thing; and afterwards conferring with the maſter of the other ſhip, (for they ſailed in company) he agreed in the ſame relation,

relation. And the captain hearing, that the ſteerſman of one of the ſhips was a *Scotſman*, he got to diſcourſe with him, and ſaw his journal too, which agreed with what the others had declared. And afterwards one of the maſters having occaſion to come to *London*, and being there met accidentally by our captain, he brought him to ſome of the Northern company, to whom he averred the foregoing relation, of whoſe truth the captain ſeemed to me to be convinced. I aſked him ſeveral queſtions relating to this odd ſtory, to divers of which he could make no anſwer, having not aſked them of his *Dutchmen*; but to ſome few things he gave anſwers, the ſubſtance whereof was, that though there were vaſt regions of ice towards the ſhores, yet where they found themſelves ſo near the pole, the ſea was very open and free; ſo that if wood and water had not begun to fail them, and if they had not feared their other proviſions would not hold out, they might have made a paſſage perhaps as far as *Japan*. That from the north-eaſt there came a great rolling ſea, which one of the maſters, that had been at the bay of *Biſcay*, compared to that *Spaniſh* ſea; and that the cold there was not extreme, but ſuch as they could well endure, and complained no more of, than they did in *Greenland*. That ſailing from *Greenland* towards the pole, they found the compaſs to vary a point, after they had ſailed ſome degrees northward; then the variation of it was for a great while inconſiderable, and a while after that, it came to be two points. And laſtly, when they came to be ſo near the pole, the declination increaſed ſtrangely; ſo that at 89 degrees of latitude they found the variation to be four, not degrees, but points of the compaſs, and that towards the eaſt.

9. THE old ſea-captain told me, that they are in the ſeas frequently peſtered with thick fogs extremely cold, which laſt ſome of them 10 or 12 hours, ſome a whole day, and others two or three days.

HE told me, that lying at anchor in *Bell-Sound* on the coaſt of *Greenland*, near a mountainous rock, that was very high, he and ſome others made a ſhift to get up to the top, which he judged to have half a mile of perpendicular height; and when they came to the upper part of the mountains, they found the weather very clear, and the ſky very ſerene; and it being then *June*, the ſun ſhined ſo hot upon them, that he and others ſtripped themſelves, and aired their ſhirts and naked bodies to cool themſelves, ſeeing all the while a thick fog like clouds at the bottom of the hill; whither when they came down with ſtore of fowl, that they had killed, they found the fog, as they left it, very dark, and exceeding cold.

### *A paſſage taken out of the* Czar's *doctor's letters.*

10. *Aug.* 29, 1664. This winter we ſtayed at *Vologda* three months, which is north-eaſt from *Moſcow* ſome degrees. I expected the intenſe cold, which is uſually felt there; but (as it happened) we had not three days of that, which we call winter-weather there, notwithſtanding we were there in *December*, in which month it rained unuſual and dangerous. The cold, which is ſo much talked of in books, hath been rare in theſe late years; for ſome *Engliſh*, which have lived there thirty years ſince, have obſerved ſuch an alteration in the climate, that, except I had good confidence in the fidelity of their relations, being men of known worth and ſobriety, I ſhould not adventure to tell you, that in theſe thirty years the winters are become ſo mild, as the notable cold weather, which uſes to freeze people in their way coming to market in ſeveral poſtures, as they were ſtriking their horſes, or guiding their ſledges, hath been rarely felt, only to the freezing the noſes and cheeks of ſome people, which may rather be termed a blaſt, than a ſettled intenſe cold.

11. THE warmer the room is made by day, the thicker is the hoar upon the glaſs at night, ſometimes an inch thick, which I have ſeen. If it be a ſmall froſt, the nails only of the windows, which faſten the latten together, will be tipt with white; all the nails of inſides of doors, and iron work, will be adorned with the froſt, and going out of the door you will endanger your breath.

THE falconers here ſay, birds creep under the ſnow at nights.

ASSUREDLY the bears provide themſelves with a cave againſt the winter. I have kept a bear two days without meat or drink, he ſtill ſucking his paws, making a lather with his tongue; and, had he not ſmelt the meat of the houſe, which made him craving and clamorous, no doubt he might have been kept much longer upon his faſt.

12. A WIND from the ſea there cauſes a thaw; ſo it does at *Archangel*, although it comes thither north.

I SHALL hereafter give you a catalogue of our plants, ſome of which are rare in *England*, but here in quantity, *viz.* lilium convallium, pyrola, bifolium, polygonatum, *&c.* I ſhall a little inform you concerning the vegetable lamb, which *Olearius* calls *baromets*.

13. BUT he told me they uſed very little phyſick, the air being ſo healthful, as that it is no rare thing to ſee people 80 or 100 years old; eſpecially the poorer ſort, that do not indulge themſelves with ſtrong drink.

14. THE ſame captain anſwered me, that in *Greenland* itſelf the north-eaſt winds were colder than any other, which yet he aſcribed in part to the ſituation of the country, thoſe winds blowing over vaſt tracts of ice, without ſea to mitigate the cold they communicated to the wind.

### *Particulars referable to the* XIXth *Title.*

1. LIEUTENANT *G. Drummond*, who for ſome years was governour of *Smolenſco*, told me, that he had many times barrels little leſs than our hogſheads of ſtrong beer, which being left night and day in the ſledges upon the ſnow, would be frozen all about next the caſk to a conſiderable thickneſs, ſo that the gimlet muſt pierce the ice a great way, before the veſſel would be ſet abroach; but then the liquor, which came forth, would not only be much ſtronger than the beer was at firſt, but much more pleaſantly taſted.

2. LIEUTENANT *G. Drummond* confirmed what others had told me, of the great noiſe, like the diſcharge of muſkets, that they hear in the wooden houſes, whoſe walls are made of fir-trees (unſquared, and only diſbarked) upon very intenſe froſts; and he aſſured me, the great cracks or flaws, that appeared in the timber after theſe exploſions, were barely clefts made by the burſting of the trees, without any ſplinters, or other parts of the wood thrown off from the body of the timber.

3. THE two Swediſh Ambaſſadors aſſured me, that it is true, that in *Muſcovy*, and ſome other northern countries alſo, the hares are, as in theſe parts, grey, *(griſe)* but ſnow-white in winter; and that they begin to change colour in autumn, (and to recover it in the ſpring.) And the elder of them, Monſieur *Coyet*, being aſked of me, if he himſelf had obſerved it, he aſſured me, that he had. It was likewiſe affirmed by the Swediſh Reſident, who was then preſent, and related it to me before them, that in the borders of *Muſcovy* he had ſeen ſtore of partridges milk-white: when I aſked, whether they changed colour in ſummer, or were not rather conſtantly white: he anſwered me, he could not tell, it being winter when he was there. And when I inquired, whether there were not ſome other beſides hares, that changed

colour according to the ſeaſons, they all three told me, that ſquirrels, which in the ſummer are of the uſual colour, do in the winter turn grey, and recover their colour in the following ſummer.

THEY were pleaſed alſo to ſend me word the next day by an ingenious gentleman, ſon to Monſieur *Coyet*, that they had forgot to tell me, that whereas the river *Duna* divides *Livonia* and *Muſcovy*, on one ſide of the river the hares are of the ordinary colours, but on the other ſide white. So that when the hunters meet with any white hares on this ſide of the river, they ſay it is a *transfuga*.

4. AMONGST the odd effects of cold in *Ruſſia*, and ſome other countries, where that quality reigns in winter, it is none of the leaſt admired, that if a man be abroad in the air with a cane or ſtaff furniſhed with a metalline head, the cold is ſo intenſe in that compact body, that the tip of the tongue being applied to the metal, they will ſtick, and be (as it were) glewed together, ſo that a man cannot ſever them without great pain, and ſometimes without leaving ſome of the ſkin of his tongue behind upon the handle of the ſtaff; as it has been affirmed to me by eye-witneſſes of unqueſtionable credit. The reaſon of this odd phænomenon, as far as I can conjecture, may be the great and ſudden loſs of agitation occaſioned in the ſpittle and part of the tongue, by the great want of agitation in the parts of the metal that they touch. For if a bowl (for inſtance) of ivory meet in a direct line with another of the ſame bigneſs, that is already moving upon a billiard-table, it will communicate to it but a part of its own motion, and ſo retain the reſt for itſelf: but if the impelled bowl were at reſt, the impelling bowl will communicate to it all, or almoſt all its motion, and loſe as much itſelf, as may appear by its remaining quieſcent in the place of the other. I muſt not inlarge upon this ſubject of motion among bodies, that hit againſt others. But to apply the obſervation to my preſent purpoſe, it ſeems the metalline handle of the ſtick, by the intenſeneſs of the cold, has its parts ſo deprived of motion, that when thoſe of ſpittle and the tongue have communicated to them as much of their agitation as they can, there will not be between thoſe three bodies agitation enough to keep the ſpittle fluid, which conſequently being turned into ice, will ſtick to the two conſiſtent bodies it adhered to, namely, the tongue and the metal, and by this means will faſten them together.

IN confirmation of this conjecture I ſhall add ſome other phænomena, which may be explicated by the help of it. And firſt we ſee, that in very froſty mornings the ice, that ſticks to glaſs-windows, often appears in the form of trees, or otherwiſe oddly and prettily figured. This is vulgarly ſo explained, as if the cold produced thoſe icy bodies on the outſide of the glaſs, through which, ſome fancy, that the vapours of the warm room penetrate: but it is plain, that this ice uſes to be formed within the room, as I have divers times obſerved, either by the thawing of it, or by ſcraping it off; ſo that it appears to be formed of vapours, which being carried to and fro by the air, when they chance to paſs along the glaſs-panes of the windows, which by the cold, that reigns in the external air in froſty weather, have loſt the wonted agitation of their parts, theſe vapours transfer ſo much of their motion to the glaſs, that they retain not enough to keep them fluid; the conſequence of which is their being turned into ice, which in very cold countries may be far thicker than it uſes to be here: inſomuch that a learned acquaintance of mine aſſured me, that he had in *Ruſſia* obſerved in ſome ſtoves, (where it is like the heat produced ſtore of vapours) that the ice on the inſide of the windows was near an inch thick.

### *A note out of* Martinius, *in his account of* China.

5. *In* Peking *elevatione Poli* 42. *gr. per integros quatuor menſes facto circa Novembris medium initio, flumina omnia adeò duro concreſcunt gelu, ut currus, equoſque, ac graviſſima quæque onera glacies tutò ferat. Hæc plerumque concretio uno fit die; cùm non niſi pluribus, & quidem ab inferiori ſuperficie priùs, fuit liquefactio. p.* 27. ‘*Martinius* in his account of *Peking* p. 27. tells us, that although the pole be not elevated above 42 degrees, yet for four whole months, from the middle of *November*, all the rivers are ſo bitterly frozen over, that the ice will ſafely bear coaches, and horſes, and all the heavieſt burdens. This congelation is for the moſt part made in one day; but the melting of the ice requires many, and begins from the lower ſurface.’

### *A note taken out of* Martinius Cromerus *his* Polonia, *lib.* 1. *p.* 53, 54.

6. *Tanta eſt enim vis frigoris in his regionibus interdum, ut radicitus areſcant arbores, & aqua ex editiori loco effuſa, priuſquam terram contigerit, in glaciem concreſcat. Lacus quidem, & paludes, & flumina duobus tribuſve menſibus hibernis, nonnunquam autem vel in quintum vel ſextum uſque concreta glacie, non modo peditibus, verum etiam equitibus, & curribus ac plauſtris, quamvis oneratis, multis ſimul longo ſpatio pervia & ſecura præbent itinera. Equidem quodam tempore ultimo die menſis Martii* Viſtulam *in* Maſovia *per firmam adhuc glaciem, cum curru & quadrigis, & aliquot equitum comitatu tranſivi. Hâc etiam præteritâ hyeme in* Pruſſia *glacialis piſcatio in lacubus poſt initium Novembris cœpta, duravit per totum Martium, gelu autem per totum Aprilem.* ‘So great is the violence of cold ſometimes in theſe countries, that trees wither at the roots; and water poured out from an high place, turns into ice before it comes to the ground. And truly the lakes, and marſhes, and rivers are ſo frozen for two or three months in winter, and ſometimes for five or ſix, that not only footmen, but alſo horſemen, and coaches, and waggons, though loaded, may for a long ſpace freely and ſecurely paſs over them. Truly once I paſſed over the *Weiſſel* in *Maſovia* upon the firm ice the laſt day of *March*, with a coach and four horſes, and a retinue of ſome horſemen; and this laſt winter in *Pruſſia* the fiſhing in the ice began in the lakes after the beginning of *November*, and continued all *March*, but froſt laſted all *April*.

### *A note taken out of* Cromerus's Polonia, *lib.* 1. *p.* 68.

*In cæteris lacubus, atque etiam in majoribus piſcinis & fluminibus tempore hyberno commodiores ferè ſunt piſcationes, quàm æſtate, pertuſâ certis intervallis glacie, retique per majus foramen in aquam immiſſo: quod longis funibus ad perticas alligatis hominum equorumve operâ longo ſpatio in diverſum tractum, coëuntibus rurſus piſcatoribus, alio foramine refertum extrahitur.* ‘In other lakes, and in the larger fiſh-ponds, and rivers, fiſhing is more commodious in winter than in ſummer, the ice being broken in ſome places, and a net caſt into the water through a great hole, which by long ropes tied to poles, men and horſes draw different ways for a conſiderable ſpace; and then the fiſhermen meeting together, take it up well filled at another hole.’

7. AN ingenious phyſician confirmed to me upon trial, that the pummel of a ſword, that was expoſed to the winter-air in *Moſcow*, would ſtick to his tongue, that touches it therewith, and fetch off the ſkin, if he forcibly and ſuddenly pulled it away.

8. A GENTLEMAN, that came lately from *Warſaw*, told me, that in one night, or rather twelve hours, he obſerved this winter the ice next the ſurface of the water to reach four inches directly downwards.

9. THE old ſea-captain told me, that when he was in *Greenland*, and in thoſe artick regions, his appetite was ſo great, that he could well eat more in one day, than he could in a week or ten days here; and that accordingly he and others found themſelves ſtronger there than here, and more prone to venereal pleaſures.

HE told me alſo, that ſailing with intention to make ſome diſcovery into the artick circle, that after having ſailed a great while through a ſea exceeding blue and deep, they were as much ſurprized to find themſelves on a ſudden upon a ſea black almoſt like ink, which much frighted them, none of all their wanderers having met with a ſea of that colour. This made them, after many diſputes and doubts, reſolve to ſound both from their ſhip and ſhallop, but they could find no ground at ſeventy fathom.

10. A BOTTLE of ſtrong ſack, about two thirds filled, cracked, and the wine was frozen, *viz.* the phlegm, but no ice on the top, as in water; nor does the phlegm ever aſcend to the top, to be frozen in an entire body.

THIS ſack being preſently thawed, loſt its vigour, and ſo will any thing elſe.

11. THE froſt in theſe parts pierces the ground five foot, which the undertakers for digging a cellar for a friend of mine found by woful experience, being forced to make their way by fire, and ſometimes by cleaving the earth with wedges like a rock.

THE ice in *Siberia* in the river *Ob* is ſaid to be a fathom and a half thick, where they have in the whole year but twelve weeks of degelation.

THE rivers, that I have travelled over, have breathing-places for a mile, ſometimes half a mile, and a quarter, out of which comes a fume like that of the *Croſs-Bath* or *King's Bath* at the *Bath*. The like out of a cellar upon the opening of the door, enough to ſuffocate a man, if taken unawares.

DEATH by cold is not painful, eſpecially if the cold be very intenſe; as a friend of mine told me, who waiting upon his uncle here (a colonel) in quality of a page, he ſate upon the ſide of the ſledge, as ſervants do, and it being very cold, he ran to get himſelf ſome heat in his feet, and afterwards returned to ſit upon the ſledge, and found himſelf ſurprized with the cold, but had not the power to prevent the danger of ſuffocation by calling for help; yea, rather he ſeemed to be pleaſed with falling into a pleaſing ſleep, and ſo tumbled back upon his uncle's legs, which raiſed a ſuſpicion in him, that his couſin was frozen: and ſo making haſte to the next village, he rubbed him all over with ſnow ſtrenuouſly enough, and afterwards brought him into a warm room, which by degrees revived him, he feeling himſelf afflicted and pained in all his limbs with ſuch a tingling numbneſs, as they uſe to have who leaned too hard upon their elbows, but much more painful and amazing.

12. THAT cold dries exceſſively, appears by the ſtory of the cheeſes, and ſtock-fiſh, which is dried in the wind, ſome of which is ſprinkled with ſalt. The earth will cleave with it, but I never obſerved it cracked with ſuch monſtrous hiatus, as *Olearius* reports; yet that may be true alſo. Where there is froſt long before the ſnow comes, the ice in rivers will have cracks.

ABOUT the middle of *December* being at *Yewſlave* in my lodging in a morning before day, the houſe being new, and expoſed to the north-eaſt wind, it gave a crack like a muſket.

### *Particulars referable to the* XX$^{th}$ *Title.*

1. A sealed glaſs-bubble with quickſilver in it weighed in the air, and being carefully counterpoiſed in water, that to my hand, whilſt I was ſitting by the fire-ſide, felt luke-warm, did, after ſnow and ſalt were applied on the out-ſide of the glaſs, that held the water, weigh $\frac{3}{4}$ of a grain, or ſomewhat better, before or juſt when there appeared a little film of ice on the inſide of the glaſs, containing the water, leſs than it did when the bubble was firſt put in.

2. A globe of ſnow, rammed into the mould of juſt one inch diameter, weighed 112 grains.

3. A bullet of ice of an inch diameter, made in the ſame mould, amounted to 2 drachms, 5 grains.

4. After a long froſt and ſnow, a great deal of new ſnow being fallen laſt night, the liquor in the gaged weather-glaſs ſtands beneath the firſt mark, argues a more than ordinary froſt: and yet the mercury in the baroſcope ſtands at near $\frac{2}{8}$ beneath 29 inches, to which perhaps the high wind may contribute.

5. Four ounces of ſnow made up in a lump, were counterpoiſed in a pair of good ſcales, and expoſed in a froſty night after eleven o'clock without being taken out of the balance: the next morning between 9 and 10, there appeared a decrement of 29 or 30 grains, which ſeemed to have evaporated from the ſnow itſelf: for though a ſmall portion of it (probably late in the morning) were melted in the ſcale, yet that liquor was but little, and amounted not to 8 grains, which was not a third of the weight, which the ſnow-ball had loſt; but ſuppoſing the decrement would be greater, if the ſnow had a greater ſuperficies, in reſpect of the bulk thereof, I cauſed the next night the following trial to be made, not being able to aſſiſt at it my ſelf.

There was taken ℥ij of ſnow, which being made up into a kind of flat cake, was expoſed all night, which was froſty, in the above-mentioned balance, and the next morning about eight a clock there appeared to have been loſt 55 grains, no water being found in the ſcale; and about two hours after, the decrement was found to be about 63 grains, none of the ſnow appearing to have melted in the ſcale.

### *One particular referable to the* XXI$^{st}$ *Title.*

THE *Samejodes* clothe themſelves with *renes* ſkins, the hair outward, which they find to be the warmeſt way: and I have found a pair of *cangies* (which are like high ſhoes with pecked toes of old *Chaucer*'s faſhion, which we wear without the leather) to be better than a pair of furred gloves. They are only proper for the ſledge, yet one may walk in the ſnow with them, which is ſo dry a ſnow, if it be duly cold weather, as it will not wet at all, nor endamage a ſcarlet cloak covered all over with it, but bruſh or ſhake off like chaff.

# OBSERVABLES upon a MONSTROUS HEAD.

## Firſt Printed in the *Philoſophical Tranſactions*, N° v. p. 85. For *Monday*, July 3, 1665.

THIS was the head of a colt, repreſented in the annexed figure 4, firſt viewed by Mr. *Boyle*, who went into the ſtable where the colt lay, and got the head haſtily and rudely cut off, the body thereof appearing to his eye compleatly formed, without any monſtroſity to be taken notice of in it. Afterwards he cauſed it to be put into a veſſel, and covered with ſpirit of wine, thereby chiefly intending, to give good example, together with a proof, that by the help of the ſaid ſpirit, (which he hath recommended for ſuch properties in one of his Eſſays of the Uſefulneſs of Natural Philoſophy) the parts of animals, and even monſters, may in ſummer itſelf be preſerved long enough to afford anatomiſts the opportunities of examining them.

THE Head being opened, and examined, it was found,

FIRST, That it had no ſign of any noſe in the uſual place, nor had it any, in any other place of the head, unleſs the double bag C C, that grew out of the midſt of the forehead, were ſome rudiment of it.

NEXT, That the two eyes were united into one double eye, which was placed juſt in the middle of the brow, the noſe being wanting, which ſhould have ſeparated them, whereby the two eye-holes in the ſkull were united into one very large round hole; into the midſt of which, from the brain, entred one pretty large optick nerve, at the end of which grew a great double eye; that is, that membrane called ſclerotis, which contained both, was one and the ſame, but ſeemed to have a ſeam, by which they were joined, to go quite round it, and the fore or pellucid part was diſtinctly ſeparated into two corneas by a white ſeam that divided them. Each cornea ſeemed to have its iris, (or rain-bow like circle) and apertures or pupils diſtinct; and upon opening the cornea, there was found within it two balls, or cryſtalline humours, very well ſhaped: but the other parts of it could not be ſo well diſtinguiſhed, becauſe the eye had been much bruiſed by the handling, and the inner parts confuſed and diſlocated. It had four eye-brows, placed in the manner expreſt in figure 4, by *a a*, *b b*; *a a* repreſenting the lower, and *b b*, the upper eye-lids.

LASTLY, That juſt above the eyes, as it were in the midſt of the forehead, was a very deep depreſſion, and out of the midſt of that grew a kind of double purſe or bag, C C, containing little or nothing in it; but to ſome it ſeemed to be a production of the matter deſigned for the noſe, but diverted by this monſtrous conception; perhaps the proceſſus mammillares joined into one, and covered with a thin hairy ſkin.

## Some ANATOMICAL OBSERVATIONS of MILK found in Veins inſtead of BLOOD; and of GRASS found in the Wind-pipes of ſome Animals.

Firſt Printed in the *Philoſophical Tranſactions*, N° vi. p. 100.
For *Monday*, November 6, 1665.

A CURIOUS perſon wrote not long ſince from *Paris*, that there they had, in the houſe of a phyſician, newly opened a man's vein, wherein they found milk, inſtead of blood. This being imparted to Mr. *Boyle* at *Oxford*, his anſwer was, that the like obſervation about white blood had been made by a learned phyſician of his acquaintance; and the thing being by him looked upon as remarkable, he was deſirous to have it very circumſtantially from the ſaid phyſician himſelf, before he would ſay more of it. The next month may bring us in this account.

THE other particular mentioned in the title of this head, came in a letter ſent alſo by Mr. *Boyle*, in theſe words:

I SHALL acquaint you, that two very ingenious men, Dr. *Clarke* and Dr. *Lower*, were pleaſed to give me an account of a pretty odd kind of obſervation: one of them aſſuring me, that he had ſeveral times, in the lungs of ſheep, found a conſiderable quantity of graſs in the very branches of the aſpera arteria: and the other relating to me, that a few weeks ſince, he, and a couple of phyſicians, were invited to look upon an ox, that had for two or three days almoſt continually held his neck ſtreight up, and was dead of a diſeaſe, the owner could not conjecture at; whereupon, the parts belonging to the neck and throat, being opened, they found, to their wonder, the aſpera arteria in its very trunk all ſtuffed with graſs, as if it had been thruſt there by main force: which gives a juſt cauſe of marvelling and inquiring, both how ſuch a quantity of graſs ſhould get in there; and how, being there, ſuch an animal could live with it ſo long.

## Of a Place in *England*, where, without petrifying Water, WOOD is turned into STONE.

Firſt Printed in the *Philoſophical Tranſactions*, N° vi. as above.

THE ſame ſearcher of nature, that was alledged in the immediately precedent obſervations, did impart alſo the following, in another letter from *Oxford*, where he ſaith,

I WAS a while ſince viſited by a gentleman, who tells me, that he met with a place in theſe parts of *England*, where, though there be no petrifying ſpring (for that I particularly aſked) wood is turned into ſtone in the ſandy earth itſelf, after a better manner than by any water I have yet ſeen: for I had the curioſity to go to look upon pieces of wood he brought thence, and hope for the opportunity of making ſome trials to examine the matter a little further, than I have been yet able to do. *Thus far that letter.*

SINCE which time, he was pleaſed to give this further information of the ſame matter, with a mantiſſa of ſome other particulars, belonging to this ſubject, in theſe words:

I WAS lately making ſome trials with the petrified wood I told you of, which I find to be a very odd ſubſtance, wonderfully hard and fixed. If I had opportunity to reprint the *Hiſtory of Fluidity and Firmneſs*, I could add divers things about ſtones, that perhaps would not be diſliked; and I hope, if God vouchſafe me a little leiſure, to inſert ſeveral of them in fit places of that hiſtory, againſt the next edition. Here is a certain ſtone, that is thought to be petrified bone, being ſhaped like a bone, with the marrow taken out; but with a fit menſtruum, I found that I could eaſily diſſolve it, like other ſoft ſtones: and poſſibly it may prove as fit as oſteocolla, for the ſame medicinal uſes.

## A Farther ACCOUNT of an OBSERVATION about WHITE BLOOD.

First Printed in the *Philoſophical Tranſactions*, N° vi. p. 117.

SINCE the printing of the former ſheet, there is this farther account from the ſame hand, Mr. *Boyle*.

I HAVE at length, according to your deſire, received from the ingenious Dr. *Lower* an account in writing of the obſervation about chyle found in the blood; which though you may think ſtrange, agrees well with ſome experiments of his and mine, not now to be mentioned. The relation, though ſhort, comprizing the main particulars of what he had more fully told me in diſcourſe, I ſhall give it you with little or no variation from his own words.

A MAID, after eating a good breakfaſt, about ſeven in the morning, was let blood about eleven the ſame day in her foot; the firſt blood was received in a porringer, and within a little while it turned very white; the laſt blood was received in a ſaucer, which turned white immediately, like the white of a cuſtard. Within five or ſix hours after, he (the phyſician) chanced to ſee both, and that in the porringer was half blood and half chyle, ſwimming upon it like a ſerum as white as milk, and that in the ſaucer all chyle, without the leaſt appearance of a drop of blood; and when he heated them diſtinctly over a gentle fire, they both hardened: as the white of an egg when it is heated, or juſt as the ſerum of blood doth with heating, but far more white. This maid was then in good health, and only let blood becauſe ſhe never had her courſes, yet of a very florid clear complexion.

# HYDROSTATICAL PARADOXES,

MADE OUT BY

# NEW EXPERIMENTS,

## For the moſt part PHYSICAL and EASY.

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## The PUBLISHER's ADVERTISEMENT to the READER.

WHEN the author writ the following treatiſe, he had a deſign, as appears by ſome paſſages in the preface, to publiſh together with it ſome things, which he had divers years before provided for an Appendix to his Phyſico-mechanical treatiſe about the Air: but part of the Appendix conſiſting of experiments, which the author has ſeveral times made, but truſting to his memory, did not think it neceſſary to record, when he came to recollect particulars, he found, that ſome years, which had paſſed, ſince divers of them were tried, and variety of intervening occurrents, had made it unſafe for him to rely abſolutely upon his memory for all the circumſtances fit to be ſet down in the hiſtorical part of the deſign'd Appendix. And therefore he reſolv'd to repeat divers experiments and obſervations, that he might ſet down their phænomena, whilſt they were freſh in his memory, if not objects of his ſenſe. But though, when he writ the following Preface, he did it upon a probable ſuppoſition, that he ſhould ſeaſonably be able to repeat the intended trials; yet his expectation was ſadly diſappointed by that heavy, as well as juſt viſitation of the plague, which happened at *London*, whilſt the author was in the country; and which, much earlier than was apprehended, began to make havock of the people at ſo ſad a rate, that not only the glaſs-men there were ſcattered, and had, as they themſelves advertiſed him, put out their fires, but alſo carriers, and other ways of commerce (ſave by the poſt) were ſtrictly prohibited betwixt the parts he reſided in, and *London*; which yet was the only place in *England*, whence he could furniſh himſelf with peculiarly ſhaped glaſſes, and other mechanical implements requiſite to his purpoſes: and the ſame calamity continuing ſtill, without yet affording us any certain ground of determining, when it will end, the author chuſes rather to ſuffer the following Paradoxes to come abroad without the Appendix, (which is no way neceſſary to them, whatever they may be to it) than any longer put off thoſe ingenious perſons, that ſollicited the publication of them.

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## The PREFACE.

THE riſe of the following treatiſe being a command impoſed on me by the Royal Society, the reader will, I hope, need no more, than this intimation, to keep him from wondering to find ſome paſſages worded as parts of a diſcourſe pronounced before an aſſembly; it being not unuſual (though not neceſſary) to preſent either in writing, or by word of mouth, together with the experiments made before that illuſtrious company, an hiſtorical account of them.

But, becauſe it is probable, that ſome reader will deſire to be ſatisfied about other particulars relating to the publication of this treatiſe, I preſume it will not be amiſs, both to ſay ſomething of the reaſons, why I publiſh it as the firſt part of the preſent Appendix to my *Phyſico-mechanical Experiments*, and to give ſome account of the manner of writing it.

I had quickly both an opportunity, and an invitation to enlarge the papers, I was to read, beyond the limits of a bare deſcription of the phænomena, and matters of fact, by my having been, through ſome intervening accidents, ſo hindered from exhibiting them all together, that I was deſir'd to bring in an account in writing, that might be regiſter'd (how little ſoever worthy of ſuch company) in the Society's collection of philoſophical papers, for the ſake of thoſe members, who could not be preſent at all the experiments; ſo that, finding ſome enlargements expected from me, I was eaſily induced to add the explications of the phænomena I deſcribed, whilſt I perceiv'd, that by a ſmall addition of pains I might much gratify divers ingenious friends, that were not ſo well verſed in Hydroſtaticks, as in the other parts of real learning.

Having thus been induced to enlarge the account of my experiments, till it had attained the bulk it is now arrived at, I confeſs I was, without much difficulty, perſuaded, that to ſuffer it to paſs abroad * in the company of the Appendix, wherewith it is publiſhed, would not prove unacceptable to the curious, no more than an improper introduction to the reſt of my Appendix, and that for ſeveral reaſons.

For, firſt, the Hydroſtaticks is a part of philoſophy, which, I confeſs, I look upon as one of the ingeniouſeſt doctrines, that belong to it; theorems and problems of this art being moſt of them pure and handſome productions of reaſon, duly exerciſed on attentively conſidered ſubjects, and making in them ſuch diſcoveries as are not only pleaſing, but divers of them ſurpriſing, and ſuch as would make one at firſt wonder, by what kind of ratiocination men came to attain the knowledge of ſuch unobvious truths. Nor are the delightfulneſs and the ſubtilty of the Hydroſtaticks the only things, for which we may commend them: for there are many, as well of the more familiar, as of the more abſtruſe phænomena of nature, that will never be thoroughly underſtood, nor clearly explicated by thoſe, that are ſtrangers to the Hydroſtaticks; upon whoſe principles depend, beſides many other things, the explications of moſt of the phyſico-mechanical experiments, we have ventured to preſent the publick, and the deciſion of thoſe many controverſies, which they and the phænomena of the Torricellian experiment have occaſioned among the modern inquirers into nature.

But the uſe of this art is not alone ſpeculative, but practical, ſince not only the propoſitions it teaches, may be of great importance to navigation, and to thoſe that inquire into the magnitudes and gravities of bodies, as alſo to them that deal in ſalt-works; but that the Hydroſtaticks may be made divers ways ſerviceable to the chymiſts themſelves, to whoſe art that doctrine ſeems to be ſo little of kin, I might here manifeſt, if I could think it fit to tranſcribe, what I have † elſewhere delivered to that purpoſe.

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* About this paſſage, ſee the Publiſher to the Reader.

† Chiefly in ſeveral places of the unpubliſhed part of the Treatiſe of the *Uſefulneſs of Experimental Philoſophy*.

But that, which invited me to write ſomething of this part of philoſophy, is, not only that I think it conſiderable, but that, notwithſtanding its being ſo, I find it but very little, and not very happily cultivated. For, being not looked upon as a diſcipline purely mathematical, the generality of mathematicians have not in their writings ſo much as taken notice of it, much leſs improved it. And ſince the admirable *Archimedes*, who, in his little tract *De Inſidentibus Humido*, has left us three or four very excellent propoſitions, (but proved by no very eaſy demonſtrations) among divers others, that have more of geometrical ſubtility than uſefulneſs; thoſe mathematicians, that (like *Marinus Ghetaldus*, *Stevinius*, and *Galileo*) have added any thing conſiderable to the Hydroſtaticks, have been (that I know of) very few; and thoſe too have been wont to handle them rather as geometricians, than as philoſophers, and without referring them to the explication of the phænomena of nature. And as for the Peripateticks and other ſchool-philoſophers, though on ſome occaſions, as when they tell us, that water weighs not in water, nor air in air, they deliver aſſertions about matters belonging to the Hydroſtaticks; (which term, in this treatiſe, I often take in a large ſenſe, becauſe moſt of the things delivered about the weight of bodies, may, by eaſy variations, be made applicable to other fluids) yet they are ſo far from having illuſtrated, or improved them, that they have but broached, or credited, divers of the moſt erroneous conceits, that are entertained about them. So that, there being but few treatiſes written about the Hydroſtaticks, and thoſe commonly bound up among other mathematical works, and ſo written, as to require mathematical readers, this uſeful part of philoſophy has been ſcarce known any farther, than by name, to the generality even of thoſe learned men, that have been inquiſitive into the other parts of it, and are deſervedly reckoned among the ingenious cultivators of the modern philoſophy. But this is not all; for ſome eminent men, that have of late years treated of matters hydroſtatical, having been prepoſſeſſed with ſome erroneous opinions of the peripatetick ſchool, and finding it difficult to conſult experience about the truth of their concluſions, have interwoven divers erroneous doctrines among the ſounder propoſitions, which they either borrowed ftom *Archimedes*, and other circumſpect mathematicians, or deviſed themſelves; and theſe miſtakes being delivered in a mathematical dreſs, and mingled with propoſitions demonſtrably true, the reputation of ſuch learned men, (from which I am far from deſiring to detract) and the unqualifiedneſs of moſt readers to examine mathematical things, has procured ſo general an entertainment for thoſe errors, that now the Hydroſtaticks is grown a part of learning, which it is not only difficult to attain, but dangerous to ſtudy.

Wherefore, though neither the occaſion and deſign of this treatiſe exacted, nor my want of ſkill and leiſure qualified me to write either a body, or elements of Hydroſtaticks; yet I hoped I might do ſomething, both towards the illuſtrating, and towards the reſcue of ſo valuable a diſcipline, by publiſhing the enſuing tract; where I endeavour to diſprove the received errors, by eſtabliſhing paradoxes contrary to them, and to make the truths the better underſtood and received, partly by a way of explicating them unemployed in hydroſtatical books, and partly by confirming the things I deliver, by phyſical and ſenſible experiments. And over and above this, the more to recommend Hydroſtaticks themſelves to the reader, I have, beſides the paradoxes oppoſed to the errors I would diſprove, taken occaſion by the ſame way to make out ſome of the uſefulleſt of thoſe hydroſtatical truths, that are wont to ſeem ſtrange to beginners.

If it be here demanded, why I have made ſome of my explications ſo prolix, and have on ſeveral occaſions inculcated ſome things; I anſwer, That thoſe, who are not uſed to read mathematical books, are wont to be ſo indiſpoſed to apprehend things, that muſt be explicated by ſchemes; and I have found the generality of learned men, and even of thoſe new philoſophers, that are not ſkilled in mathematicks, ſo much more unacquainted, than I before imagined, both with the principles and theorems of Hydroſtaticks, and with the ways of explicating and proving them, that I feared, that neither the paradoxes themſelves, that I maintain, nor the hypotheſes about the weight and preſſure of the air, upon which little leſs than my whole pneumatical book depends, would be thoroughly underſtood without ſuch a clear explication of ſome hydroſtatical theorems, as, to a perſon not verſed in mathematical writings, could ſcarce be ſatisfactorily delivered in few words. And therefore, though I do not doubt, that thoſe, who are good at the moſt compendious ways of demonſtrating, will think, I might in divers places have ſpared many words without injury to my proofs; and though I am myſelf of the ſame mind I expect to find them of; yet I confeſs, that it was out of choice, that I declin'd that cloſe and conciſe way of writing, that in other caſes I am wont moſt to eſteem. For writing now not to credit myſelf, but to inſtruct others, I had rather geometricians ſhould not commend the ſhortneſs of my proofs, than that thoſe other readers, whom I chiefly deſigned to gratify, ſhould not thoroughly apprehend the meaning of them.

But this is not all, for which I am to excuſe myſelf to mathematical readers. For ſome of them, I fear, will not like, that I ſhould offer for proofs ſuch phyſical experiments, as do not always demonſtrate the things, they would evince, with a mathematical certainty and accurateneſs; and much leſs will they approve, that I ſhould annex ſuch experiments to confirm the explications, as if ſuppoſitions and ſchemes, well reaſoned on, were not ſufficient to convince any rational man about matters hydroſtatical.

In anſwer to this, I muſt repreſent, that in phyſical enquiries it is often ſufficient, that our determinations come very near the matter, though they fall ſhort of a mathematical exactneſs. And I chuſe rather to preſume upon the equity of the reader, than to trouble him and myſelf with tedious circumlocutions, to avoid the poſſibility of being miſunderſtood, or of needing his candour. And we ſee, that even mathematicians are wont, without finding any inconvenience thereby, to ſuppoſe all perpendicular lines, made by pendulous bodies, to be parallel to one another: though indeed they are not; ſince, being produced, they would meet at the centre of the earth. And to preſume, that the ſurface of every calm water, in a veſſel, is parallel to the horizon, and conſequently a plane; though, in ſtrictneſs, themſelves think it the portion of a ſphere; and though alſo I have uſually obſerved it to be higher, where it is almoſt contiguous to the ſides of the veſſel, than it is in other places.

Moreover, ſince we find, that though water will be uniformly raiſed in pumps to ſeveral heights, but not to thirty-five foot; and will, in ordinary open pipes, be almoſt of the ſame level within and without, but not if the pipe be extraordinary ſlender; upon theſe, and divers other ſuch conſiderations, I may have ſometimes made uſe of expreſſions that ſeemed not poſitive and determinate enough to be employed about matters, to which mathematical demonſtrations are thought applicable. But I elſewhere give an account of the ſcruples I have about ſuch demonſtrations, as they are wont to be applied to phyſical matters. And, in the preſent paradoxes, I think I have not done nothing, if in my hydroſtatical explications I have made it appear, that in experiments made with ſuch liquors and glaſſes, as I employed, the rules will hold without any ſenſible, or at leaſt any conſiderable error; for thereby we may learn the truth of many things, for the main, though in ſome we ſhould not have attained to the exactneſs of meaſures, and proportions, which yet our endeavours may aſſiſt others to arrive at.

AND as for my confirmation of hydroſtatical propoſitions by phyſical experiments, if ſome readers diſlike that way, I make no doubt, but that the moſt will not only approve it, but thank me for it. For though, in pure mathematicks, he, that can demonſtrate well, may be ſure of the truth of a concluſion, without conſulting experience about it; yet becauſe demonſtrations are wont to be built upon ſuppoſitions or poſtulates; and ſome things, though not in arithmetick or geometry, yet in phyſical matters, are wont to be taken for granted, about which men are liable to ſlip into miſtakes; even when we doubt not of the ratiocination, we may doubt of the concluſion, becauſe we may of the truth of ſome of the things it ſuppoſes. And this conſideration, if there were no other, will, I hope, excuſe me to mathematicians, for venturing to confute ſome reaſonings, that are given out for mathematical demonſtrations. For I ſuppoſe it will be conſidered, that thoſe, whoſe preſumed demonſtrations I examine, though they were ſome of them profeſſors of mathematicks, yet did not write meerly as mathematicians, but partly as naturaliſts; ſo that to queſtion their tenets ought not to diſparage thoſe, as well certain, as excellent and moſt uſeful ſciences, pure mathematicks, any more than that the mathematicians, that follow the Ptolemaick, the Copernican, the Tychonian, or other ſyſtems of the world, write books to manifeſt one another's paralogiſms in aſtronomical matters: and therefore (to proceed to what I was about to ſay) it cannot but be a ſatisfaction to a wary man to conſult ſenſe about thoſe things, that fall under the cogniſance of it, and to examine by experiences, whether men have not been miſtaken in their hypotheſes and reaſonings; and therefore the learned *Stevinius* himſelf (the chief of the modern writers of Hydroſtaticks) thought fit, after the end of his Hydroſtatical Elements, to add in an appendix ſome pragmatical examples, (as he calls them) that is, mechanical experiments (how cogent I now inquire not) to confirm the truth of his tenth propoſition, to which he had, not far from the beginning of his book, annexed what he thinks a mathematical demonſtration. And, about the very ſubjects we are now upon, the following paradoxes will diſcover ſo many miſtakes of eminent writers, that pretend to have mathematically demonſtrated what they teach, that it cannot but make wary naturaliſts (and it is chiefly to gratify ſuch, that I publiſh this) be ſomewhat diffident of concluſions, whoſe proofs they do not well underſtand. And it cannot but, to ſuch, be of great ſatisfaction to find the things, that are taught them, verified by the viſible teſtimony of nature herſelf. The importance of this ſubject, and the frequent occaſion I have to make uſe of this kind of apology, will, I hope, procure me the reader's pardon, if I have inſiſted ſomewhat long upon it.

AFTER what has been hitherto diſcourſed, it will be eaſy for me to give an account, why I premiſe theſe hydroſtatical paradoxes to the reſt of the Appendix, wherewith they are * now publiſhed: for ſince a great part of my work, in that Appendix, was to be a further explication of ſome things delivered in the book it is ſubjoined to, and the vindication of them from invalid objections; and ſince I have generally obſerved, that the objections, that have been, either publickly or privately, made againſt the explications and reaſonings contained in that book, were wont to proceed from unacquaintedneſs, either with the true notion of the weight and ſpring of the air, as I maintain them, or with the principles and theorems of Hydroſtaticks, or elſe from erroneous conceits about them; I thought it would much conduce to both the forementioned ends of my Appendix, if I cleared up that doctrine, to which my experiments and reaſonings have been all along conſonant; and whoſe being either not known, or miſunderſtood, ſeems to have occaſioned the objections, that have been hitherto made againſt the hypotheſes I have propoſed, or the explications I have thence given. And however, ſince the proofs, I offer for my opinions, are for the moſt part drawn from experiments new and eaſy; and that my aim is but to diſcover truths, or make them out by clearer explications, without ſuppoſing, like thoſe I diſſent from, any thing, that is either precarious, or ſcarce, if at all, intelligible; I hope, that if I ſhould not prove happy enough to reach my ends, yet the ingenious and equitable reader will approve my deſign, and be advantaged by my experiments. Of which ſome of the chiefeſt, and ſome of the moſt difficult, having been ſeen (divers of them more than once) by the Royal Society itſelf, or by inquiſitive members of it; it will, I preſume, be but a reaſonable requeſt, if the reader, that ſhall have the curioſity to try them over again, be deſired not to be haſty in diſtruſting the matters of fact, in caſe he ſhould not be able at firſt to make every thing ſucceed according to expectation. For, as eaſy as I have endeavoured to make theſe experiments, yet I dare not promiſe myſelf, that they will all of them be privileged from the fate, whereto I have obſerved other phyſico-mathematical ones to be not ſeldom obnoxious, from ſome unheeded phyſical circumſtance, by which thoſe, that are not acquainted with the ſubtleties of nature, or, at leaſt for the time, do not ſufficiently conſider them, are apt to be impoſed upon.

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* An account of this paſſage alſo may be had from the Publiſher's Advertiſement to the Reader.

THIS advertiſement will, perhaps, be beſt illuſtrated and recommended by an inſtance; and therefore I ſhall ſubjoin one, that will poſſibly ſeem ſomewhat odd.

IT has been taken notice of by two or three ingenious modern mathematicians, and I have had occaſion to make it out by particular experiments, that warm water is lighter *in ſpecie*, than cold; whence it has been deduced, that wax, and other bodies, very near equiponderant with common water, will ſwim in that which is cold, and ſink in that which is hot, or luke-warm. Which experiment, though as it may be (and perhaps it has been) tried, I readily allow to be agreeable to the known laws of the Hydroſtaticks, yet I have ſometimes undertaken, that the trial ſhould have a quite contrary effect. To that purpoſe, having taken ſome yellow bees-wax, which was formed into a pellet of the bigneſs of a cherry, and, by the help of a little lead, was made ſo near equiponderate to cold water, that, being but a very little heavier, a very ſmall diminution of its weight would make it emerge, I removed it out of the very cold water into ſome, that had been purpoſely made lukewarm (or a little more than ſo) where it quickly, ſomewhat to the wonder of the lookers on, appeared to ſwim on the top of the water. And that it might not be ſuſpected, that it was ſupported by any viſible bubbles, which I have obſerved, in ſome caſes, to buoy up even heavy bodies, and deceive the unſkilful, or unattentive; I briſkly enough ducked the bullet two or three times under water to throw them off, notwithſtanding which it conſtantly returned to float; and yet, being removed again into the ſame cold water it had been taken out of, and ducked as before, to free it from adherent bubbles, it lay quietly at the bottom, and, though raiſed ſeveral times to the upper part of the water, would immediately ſubſide to the very loweſt. Now that, which invited me to promiſe an experiment, which ſeems to contradict the principles of the Hydroſtaticks, was not any diſtruſt of thoſe principles themſelves, but a conjecture, that as by warmth the water would be made a little lighter *in ſpecie* than it was before; ſo, by the ſame warmth, the ſpirituous and more agitable parts of the wax, whoſe texture is looſe enough, would be ſomewhat (though not viſibly) expanded, and would by that expanſion gain a greater advantage towards floating, than the increaſed lightneſs of the water would give it diſpoſition to ſink. And I confirmed this conjecture by a farther experiment, which at firſt was itſelf ſomewhat ſurprizing to the beholders. For when the wax was firſt taken out of the cold water, and immediately immerſed in the warm, it would readily enough ſink; and being (with a quill or a knife) raiſed to the top of the water, it would again fall down, but more ſlowly than at the beginning; and after ſome few minutes, if it were rais'd to the upper parts of the water, it would remain afloat. (And I have known it, when it had remained a while longer at the bottom, ſo to emerge, that if I were ſure no unheeded bubbles had been newly generated, and held it up, it might be ſaid to emerge of its own accord) as on the other ſide, being put into the cold water, as ſoon as ever it was taken out of the warm, it would at the very firſt float, and being then knocked downwards, it would, readily enough, regain the upper part of the water: but if I continued to ſend it downwards about ſix or ſeven times (more or fewer) ſucceſſively, it would emerge every time more ſlowly than other, and at length not emerge at all, even when I tried it in water made heavy, by being highly infrigidated with ſalt and ſnow placed about the glaſs. Which phænomena I had thought it reaſonable to expect, becauſe I preſumed, that the wax, being removed immediately out of the warm water into the cold, muſt require ſome time to loſe the adventitious expanſion, which the warmth had given it, and muſt be deprived of it by degrees, by the coldneſs of the water, into which the wax was transferred. As, on the other ſide, there muſt be ſome time neceſſary for ſo little a warmth, as that of the tepid (or little more than tepid) water, to give the wax that addition of dimenſions, (which alſo it muſt receive by degrees) that was neceſſary, in ſpite of the rarefaction of the water, to make it float. I might add, that theſe trials were repeated, for the main, with more bullets of wax than one, and that they ſucceeded far otherwiſe, when, inſtead of a piece of wax, we employed a poiſed glaſs-bubble, in which the temperature could make either no change at all, or no conſiderable change of dimenſions. And to theſe I might add other circumſtances, if I did not remember, that I mention theſe trials but occaſionally, and to make the caution, formerly recommended to the reader, appear not to be impertinent; ſince a hydroſtatical experiment, true in itſelf, may eaſily miſcarry by overlooking ſuch circumſtances, as it is not eaſy to be aware of.

But, by this advertiſement, I would by no means divert men from being diffident of hydroſtatical traditions and experiments. For, beſides the many erroneous opinions, there are matters of fact, whoſe truth, though not queſtioned, but built upon, I think ought to be brought to trial. For, even whilſt I was concluding this preface, I found, that divers, even of the moderns, and particularly a very learned man, that has lately written of Hydroſtaticks, have much troubled themſelves to render a reaſon, why, ſince, according to their doctrine, water weighs not in water, wooden veſſels, though of a ſubſtance lighter than water, being by leaks, or otherwiſe, fill'd with water, ſhould ſink and remain at the bottom of the water: whereas, judging this phænomenon diſagreeable to what I look upon as the laws of the Hydroſtaticks, I was confirmed in that opinion, by having had the curioſity to make ſome trials of it, with four or five veſſels of differing ſhapes and ſizes, whereof two were of wax; which, though a matter but very little lighter than water, I could not ſink, or keep ſunk by pouring water into them, or ſuffering them to fill themſelves at leaks made near the bottom: and if they were depreſſed by force or weights, they, as alſo the wooden veſſels, would, upon the removal of the impediment, (and ſometimes with the cavity upwards) emerge. And I am the more ſolicitous to have things in the Hydroſtaticks duly aſcertained, becauſe the weighing of bodies in liquors may hereafter appear to be one of the general ways I have employed, and would recommend, for the examining of almoſt all ſorts of tangible bodies.

# HYDROSTATICAL PARADOXES,

MADE OUT BY

# NEW EXPERIMENTS,

Preſented to the ROYAL SOCIETY, (the Lord Viſcount BROUNCKER being then Preſident) *May* 1664.

MY LORD,

TO obey the orders of the Society, that forbid the making of prefaces and apologies, in accounts of the nature of that, which you expect from me; I ſhall, without any further preamble, begin with taking notice, that upon peruſal of Monſieur *Paſcal*'s ſmall French book, which was put into my hands, I find it to conſiſt of two diſtinct treatiſes; the one, *of the Æquilibrium* of liquors, as he calls it; and the other, *of the weight of the maſs of the Air*.

As for this latter, (which I ſhall mention firſt, becauſe I can in very few words diſpatch the little I have to ſay of it) though it be an ingenious diſcourſe, and contains things, which, if they had been publiſhed at the time, when it is ſaid to have been written, would probably have been very welcome to the curious; yet I have very little elſe to ſay of it in this place, in regard that, ſince that time, ſuch kind of experiments have been ſo proſecuted, that I preſume it is needleſs, and would not be acceptable to repeat, what Monſieur *Paſcal* has written, in this Society, which has ſeen the ſame truths, and divers others of the like nature, more clearly made out by experiments, which could not be made by Monſieur *Paſcal*, and thoſe other learned men, that wanted the advantage of ſuch engines and inſtruments, as have in this place been frequently made uſe of.

WHEREFORE, having already at a former meeting given you, by word of mouth, an account of Monſieur *Paſcal*'s ingenious invention, of a pair of bellows without vent, to meaſure the various preſſure of the atmoſphere; I remember nothing elſe, that needs hinder me from proceeding to the other part of his book, *The Treatiſe of the Æquilibrium of Liquors*.

THIS I find ſo ſhort, and ſo worthy of the author, that to give you all, that I judge worth taking notice of in it, would oblige me to tranſcribe almoſt the whole tract; and therefore I ſhall rather invite you to read the whole, than divert you from the deſign by culling out any part of it; yet, if you will not be ſatisfied without ſomething of more particular, I ſhall be obliged to tell you, that the diſcourſe conſiſting partly of concluſions, and partly of experiments, the former ſeemed to me to be almoſt all of them (there being but few that I doubt of) conſonant to the principles and laws of the Hydroſtaticks. But as for the latter, the experimental proofs he offers of his opinions are ſuch, that, I confeſs, I have no mind to make uſe of them.

AND the reaſons, why, notwithſtanding that I like moſt of Monſieur *Paſcal*'s aſſertions, I decline employing his way of proving them, are principally theſe:

FIRST, Becauſe though the experiments he mentions be delivered in ſuch a manner, as is uſual in mentioning matters of fact; yet I remember not, that he expreſly ſays, that he actually tried them, and therefore he might poſſibly have ſet them down, as things, that *muſt* happen, upon a juſt confidence, that he was not miſtaken in his ratiocinations. And of the reaſonableneſs of this doubt of mine, I ſhall ere long have occaſion to give an inſtance.

SECONDLY, Whether or no Monſieur *Paſcal* ever made theſe experiments himſelf, he does not ſeem to have been very deſirous, that others ſhould make them after him. For he ſuppoſes the phænomena he builds upon to be pruduced fifteen or twenty foot under water. And one of them requires, that a man ſhould ſit there with the end of a tube leaning upon his thigh; but he neither teaches us, how a man ſhall be enabled to continue under water, nor how, in a great ciſtern full of water, twenty foot deep, the experimenter ſhall be able to diſcern the alterations, that happen to mercury, and other bodies at the bottom.

AND thirdly, Theſe experiments require not only tubes twenty foot long, and a great veſſel of, at leaſt, as many feet in depth, which will not in this country be eaſily procured; but they require braſs cylinders, or plugs, made with an exactneſs, that, though eaſily ſuppoſed by a mathematician, will ſcarce be found obtainable from a tradeſman.

THESE difficulties making the experiments propoſed by Monſieur *Paſcal* more ingenious than practicable, I was induced, on this occaſion, to bethink myſelf of a far more expeditious way to make out, not only moſt of the concluſions, wherein we agree, but others, that he mentions not; and this with ſo much more eaſe and clearneſs, that not only this illuſtrious aſſembly, but perſons, no more than moderately verſed in the vulgar principles of the Hydroſtaticks, may eaſily enough apprehend, what is deſigned to be delivered, if they will but bring with them a due attention, and minds diſpoſed to prefer reaſon and experience to vulgar opinions and authors; which laſt clauſe I annex, becauſe the following diſcourſe, pretending to confute ſeveral of thoſe, challenges a right to except againſt their authority.

IT not being my preſent taſk to deliver the elements, or a body of Hydroſtaticks, but only ten or twelve paradoxes, which I conceive to be proveable by this new way of making them out; I ſhall, to avoid confuſion, deliver them in as many diſtinct propoſitions: after each of which, I ſhall endeavour in a proof, or an explication, to ſhew, both that it is true, and why it ought to be ſo. To all theſe I ſhall, to avoid needleſs repetitions, premiſe a word or two by way of poſtulatum, or lemma.

AND becauſe I remember, to what aſſembly I addreſs this diſcourſe, I ſhall make uſe of no other, than an eaſy ſuppoſition I met with, in a ſhort paper (about a mercurial phænomenon) brought in a year or two ſince to this learned Society, by a deſervedly famous member of it *: for though his ſuppoſal be made upon occaſion of an experiment of another nature, than any of the enſuing, it may be eaſily accommodated to my preſent purpoſe.

THIS poſtulatum, or lemma, conſiſts of three parts; the firſt of them more, and the two laſt leſs principal.

SUPPOSE we then, firſt, that if a pipe open at both ends, and held perpendicular to the horizon, have the lower of them under water, there paſſes an imaginary plane or ſurface, which touching that orifice, is parallel to the horizon, and conſequently parallel, as to ſenſe, to the upper ſurface of the water; and this being but a help to the imagination, will readily be granted.

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* That excellent mathematician, the learned Dr. *Wallis*, Savilian Profeſſor of Geometry.

SECONDLY, To this it will be conſonant, that each part of this deſignable ſurface will be as much, and no more preſſed, as any other equal part of it, by the water that is perpendicularly incumbent on it. For the water, or other fluid, being ſuppoſed to be of an homogeneous ſubſtance, as to gravity, and being of an equal height upon all the parts of the imaginary ſurface; there is no reaſon, why one part ſhould be more preſſed by a perpendicular pillar of that incumbent fluid, than any other equal part of the ſame ſurface by another perpendicularly incumbent pillar of the ſame, or equal baſis and height, as well as of the ſame liquor.

BUT thirdly, Though whilſt our imaginary ſurface is equally preſſed upon in all parts of it, the liquor muſt retain its former poſition; yet, if any one part comes to have a greater weight incumbent on it, than there is upon the reſt, that part muſt be diſplaced, or depreſſed, as it happens, when a ſtone, or other body heavier than water, ſinks in water. For wherever ſuch a body happens to be underneath the water, that part of the imaginary plane, that is contiguous to the lower part of the ſtone, having on it a greater weight, than other parts of the ſame ſurface, muſt needs give way; and this will be done ſucceſſively, till the ſtone arrive at the bottom. And if, on the other ſide, any part of the imaginary ſurface be leſs preſſed upon than all the reſt, it will, by the greater preſſure on the other parts of the ſurface, be impelled upwards, till it have attained a height, at which the preſſure (of the raiſed water, and the lighter or floating body, if any there be, that leans upon it and gravitates together with it upon the ſubjacent part of the imaginary ſurface) will be equal to that, which bears upon the other parts of the ſame ſurface.

AND becauſe this ſeems to be the likelieſt thing to be queſtioned in our † aſſumption, though he, that conſiders it attentively, will eaſily enough be induced to grant it; yet I ſhall here endeavour to evince it experimentally, and that by no other way of proof, than the ſame I employ all along this preſent diſcourſe.

TAKE then a cylindrical glaſs pipe, of a convenient bore, open at both ends; let the tube be ſteadily held perpendicular to the horizon, the lower end of it being two or three inches beneath the ſurface of a convenient quantity of water, which ought not to fill the glaſs veſſel, that contains it. The pipe being held in this poſture, it is manifeſt, that the water within the pipe will be almoſt in a level with the ſurface of the water without the pipe, becauſe the external and internal water (as I am wont for brevity's ſake to call them) have free intercourſe with one another, by the open orifice of the immerſed end of the pipe; yet I thought fit to inſert the word *almoſt*, becauſe, if the pipe be any thing ſlender, the ſurface of the water in it will always be ſomewhat higher than that of the water without it, for reaſons, that it is not ſo neceſſary we ſhould now inquire after, as it is, that we ſhould here deſire to have this taken notice of once for all; that miſtakes may be avoided without a troubleſome repetition of the difference in heights of the ſurface of liquors within pipes and without them, in caſe they be any thing ſlender.

THE pipe being held in the newly-mentioned poſture, if you gently pour a convenient quantity of oil upon the external water, you ſhall ſee, that as the oil grows higher and higher above the ſurface of that water, the water within it will riſe higher and higher, and continue to do ſo, as long as you continue to pour on oil; of which the reaſon ſeems manifeſtly to be this; that in the imaginary plane, that paſſes by the orifice of the immerſed end of the pipe, all that is not within the compaſs of the orifice, is expoſed to an additional preſſure from the weight of the oil which ſwims upon the water, and that preſſure muſt ſtill be increaſed, as there is more and more oil poured on: whereas a circular part of the imaginary plane, equal to the orifice of the glaſs, is by the ſides of the pipe fenced from the immediate preſſure of the oil; ſo that all thoſe other parts of the water, being far more preſſed, than that part, which is comprehended within the cavity of the tube, and conſequently the preſſed parts of the external water are, by the equal gravitation of the oil upon the parts of the external water, impelled up into the cavity of the pipe, where they find leſs reſiſtance than any where elſe, till they arrive at ſuch a height, that the cylinder of water within the pipe does as much gravitate upon the ſubjacent part of the imaginary ſurface, as the water and oil together do upon every other equal part of the ſame ſurface or plane.

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† This Experiment, and the Explication of it, if to ſome they ſhould here ſeem ſomewhat obſcure, will be eaſily underſtood by the Figures and Explications belonging to the firſt enſuing paradox.

BUT as well the former lemma, as this experiment, will be ſufficiently both cleared and confirmed by the following explications; to which I ſhould for that reaſon forthwith proceed, were it not, that, ſince divers paſſages of the following treatiſe ſuppoſe the air to be a body not devoid of weight, which yet divers learned adherents to the Peripatetick philoſophy do reſolutely deny, it ſeems requiſite to premiſe ſomething for the proof of this truth.

AND though I think the arguments we have employed to that purpoſe already, do ſtrongly evince it; yet, if I may be allowed to anticipate one of my own experiments of the Appendix, I ſhall give an inſtance of the weight of the air, not liable ſo much as to thoſe invalid objections, which ſome of the Ariſtotelians have made againſt thoſe proofs, wherewith we have been ſo happy, as to ſatisfy the learnedeſt even of our profeſſed adverſaries.

WE cauſed then to be blown at the flame of a lamp a bubble of glaſs, (of about the bigneſs of a ſmall hen-egg) which, that it might be light enough to be weighed in exact ſcales, ought to be of no greater thickneſs than is judged neceſſary to keep it from being (when ſealed up with none but very much expanded air in it) broken by the preſſure of the ambient atmoſphere. This bubble was (like a pear with its ſtem) furniſhed with a very ſlender pipe of glaſs, at which it was blown, that it might be readily ſealed up; and then, (the air within it being by the flame of the lamp gradually rarified, as much as conveniently could be) whilſt the body of the bubble was exceeding hot, the newly-mentioned ſtem was nimbly put into the middle of the flame; where, by reaſon of its ſlenderneſs, the glaſs, which was exceeding thin, was immediately melted, whereby the bubble was hermetically ſealed up. This glaſs being permitted leiſurely to cool, I could afterwards keep it by me an hour, or a day, or a week, or longer, if I thought fit; and when I had a mind to ſhew the experiment, I put it in one of the ſcales of an exact balance, that would turn, perhaps, with the thirtieth, or fiftieth, or a leſs part of a grain; and having carefully counterpoiſed it, I then warily broke off the ſealed end, placing a ſheet of paper juſt under the ſcale, to receive the fragments of the glaſs; and putting in again thoſe fragments, that ſcale, wherein the glaſs was, would conſiderably preponderate; which it muſt do upon the account of the weight of air; there being no other cauſe, either needful, or juſtly aſſignable, but the weight of the air that ruſhed into the cavity of the glaſs, as finding leſs reſiſtance there than elſewhere, by reaſon that the included air had its ſpring much weakened by its great expanſion.

THIS experiment I many times tried, ſometimes before ſome Virtuoſi, and ſometimes before others; who all allowed it to be concluſive. For here it could not be objected, as againſt the weighing of air in a bladder, (which objections yet I could eaſily anſwer, if it were now proper) that the air, which ponderates, is ſtuffed with the effluvia of him, that blows the bladder, and (beſides that) is not air in its natural ſtate, but violently compreſſed. For here it is the free air, and in its wonted laxity, that makes the glaſs preponderate.

AND that there is a great ingreſs of the external air, is evident by theſe three phænomena. The one, that if you lend an attentive ear, you ſhall plainly hear a kind of whiſtling noiſe to be made by the external air, as it ruſhes violently in upon the breaking of the glaſs; the other, that the rarefaction of the air ſealed up in the bubble being very great, there is a great deal of ſpace left for the ambient air to fill upon its admiſſion; and the greatneſs of this rarefaction may be gueſſed at, both by the breaking of ſuch bubbles now and then by the preſſure of the external air, which is not competently aſſiſted by the internal to reſiſt; and alſo by the third phænomenon I intended to take notice of, namely, That, if, inſtead of breaking off the ſealed end of the glaſs in the air, you break it under water, that liquor will, by the preſſure of the atmoſphere, be forced to ſpring up like an artificial fountain into the cavity of the bubble, and fill about three quarters of it. By which laſt circumſtance I gather, that the weight of the air is more conſiderable, than even many, who admit the air to have weight, ſeem to imagine. For we muſt not ſuppoſe, that all the air contained in the bubble, when broken, weighs no more, than the weight requiſite, in the oppoſite ſcale, to reduce the balance to an æquilibrium; ſince this additional weight is only that of the air, that intrudes on the breaking of the glaſs; which air, by the obſervations newly mentioned to have been made with water, appears to be but about three quarters of the whole air contained in the broken bubble; and yet, according both to our eſtimate, and that of divers Virtuoſi, and ſome of them eminent mathematicians, when the capacity of the bubble was ſhort of two cubical inches, (and ſo proportionably in other glaſſes) the nice balance we uſed, manifeſted the newly-admitted air to amount to, ſometimes, near half a grain, and ſometimes beyond it.

AND becauſe one of the laſt experiments that I made to this purpoſe, with ſealed bubbles, was none of the leaſt accurate, I ſhall conclude this ſubject with the following account of it:

A THIN glaſs bubble, blown at the flame of a lamp, and hermetically ſealed, when the contained air was exceedingly rarified, was counterpoiſed in a nice pair of ſcales; and then the ſealed *apex* being broken off, and put again into the ſame ſcale, the weight appeared to be increaſed by the re-admitted air, a pretty deal above $\frac{11}{16}$ths, and conſequently very near, if not full $\frac{3}{4}$ of a grain. Laſtly, having by ſome ſlight (for it is no very eaſy matter) filled it with common water, we weighed the glaſs and water together, and found the latter, beſides the former, to amount to nine hundred and ſix grains. So that ſuppoſing, according to our former eſtimate, countenanced by ſome trials, that the re-admitted air, which amounted to $\frac{3}{4}$ of a grain, filled but $\frac{3}{4}$ of the whole cavity of the bubble, the air that was in it, when ſealed, poſſeſſing one quarter of that cavity, the whole air contained in the bubble may be reaſonably preſumed to weigh a whole grain; in which caſe we might conclude (abſtracting from ſome little niceties, not ſo fit to be taken notice of here, as elſewhere) that the water in our experiment weighed very little more, than nine hundred times as much as an equal quantity of air. And therefore, though we allow, that in an experiment ſo diligently made as this was, the air pre-exiſtent in the bubble did not adequately poſſeſs ſo much as a fourth part, but about a fifth, or a ſixth of its cavity, the air will yet appear ſo heavy, that this experiment will agree well with thoſe others, recorded in another treatiſe, wherein we aſſigned (*numero rotundo*) a thouſand to one, for the proportion wherein the ſpecifick gravity of water exceeds that of air.

## PARADOX I.

*That in water, and other fluids, the lower parts are preſſed by the upper.*

PROVIDE a glaſs-veſſel of a convenient height and breadth, A, B, C, D, filled with water almoſt to the top; then take a glaſs-pipe, open at both ends, cylindrical, and of a ſmall bore, (as about the eighth, or ſixth part of an inch in diameter.) Put the lower end of this pipe into clear oil, or ſpirit of turpentine; and having, by ſuction, raiſed the liquor to what part of the pipe you think fit, as ſoon as it is there, you muſt, very nimbly removing your lips, ſtop the upper orifice with the pulp of your finger, that the raiſed liquor may not fall back again: then, taking the pipe, and that liquor out of the oil of turpentine, place it perpendicularly in the glaſs of water, ſo as that the ſurface of the oil in the pipe be ſomewhat higher than that of the water without the pipe; and having ſo done, though you take off your finger from the upper orifice of the pipe, the oil will not fall down at the lower orifice, though that be open, but will remain ſuſpended at the ſame height, or near thereabouts, that it reſted at before.

Now oil of turpentine, being a heavy fluid, does, as ſuch, tend downwards; and not being ſtopped by the glaſs itſelf, whoſe lower orifice is left open, it would certainly fall down through the pipe, if it were not kept ſuſpended by the preſſure (upwards) of the water beneath it; there appearing no other cauſe, to which the effect can reaſonably be aſcribed, and this being ſufficient to give an account of it, as we ſhall preſently ſee. For that it is not any contrariety in nature, betwixt the oil and the water, as liquors, that will not mingle, is evident from hence; that if you had removed your finger, when the pipe was not ſo deeply immerſed in the glaſs, but that the ſurface of the oil in the pipe was an inch or two more elevated above that of the water in the glaſs, than in our preſent caſe we ſuppoſe it to be; the oil, notwithſtanding its preſumed contrariety to water, would have freely ſubſided in the pipe, till it had attained an equipollency of preſſure with the external water.

THE reaſon, therefore, of the phænomenon ſeems to be plainly this: Suppoſing the imaginary ſurface, on which the extremity Q and the pipe P Q leans, to be G H. If that part of the ſurface, on which the oil leans at Q, be as much, and no more charged, or preſſed upon by the weight of the incumbent cylinder of oil Q X, than the other parts of the ſame imaginary ſurface G H are by the water incumbent on them, there is no reaſon, why that part at Q ſhould be diſplaced, either by being depreſſed by the weight of the cylinder of oil X Q, or raiſed by the equal preſſure of water upon the other parts of the ſuperficies G H.

AND that this æquilibrium, betwixt the oil and the water, is the true cauſe of the phænomenon, may be confirmed by obſerving what happens, if the altitude of either of the two liquors be altered in relation to the other.

AND, firſt, we have already taken notice, that if the cylinder of oil reach, in the pipe, much higher than that of the ſurface of the water, the oil will deſcend: of which the reaſon is, becauſe, the deſignable ſurface G H being more charged at Q than

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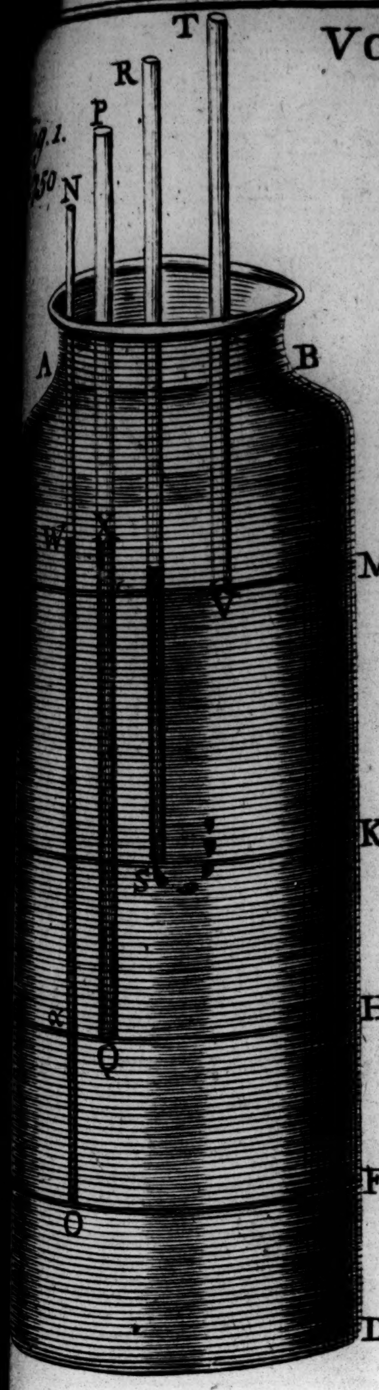
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Fig. 2. p. 755.

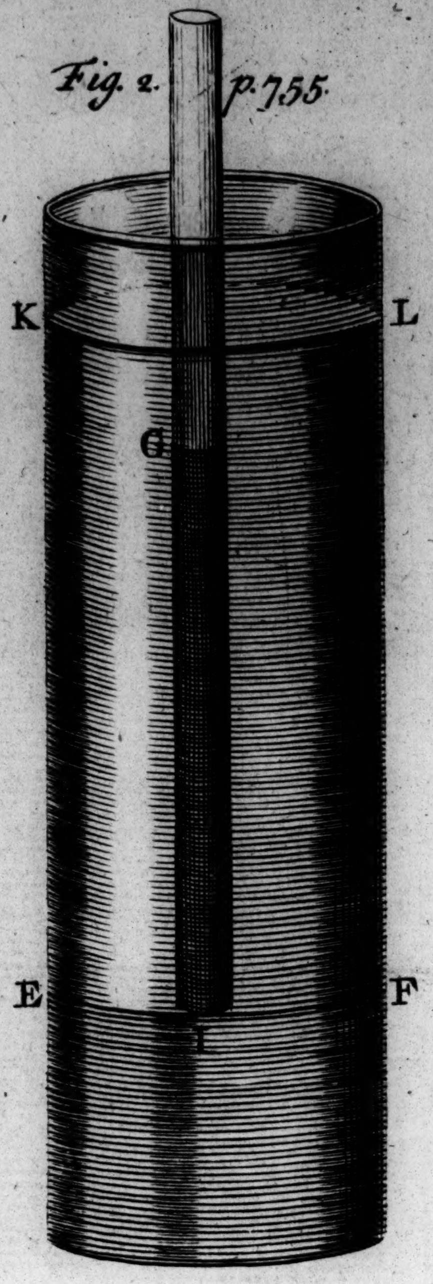

Fig. 3. p. 756.

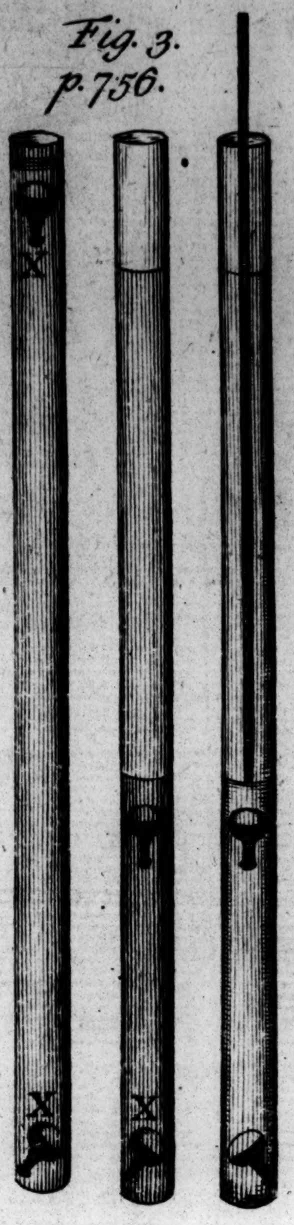

Fig. 4. p. 760.

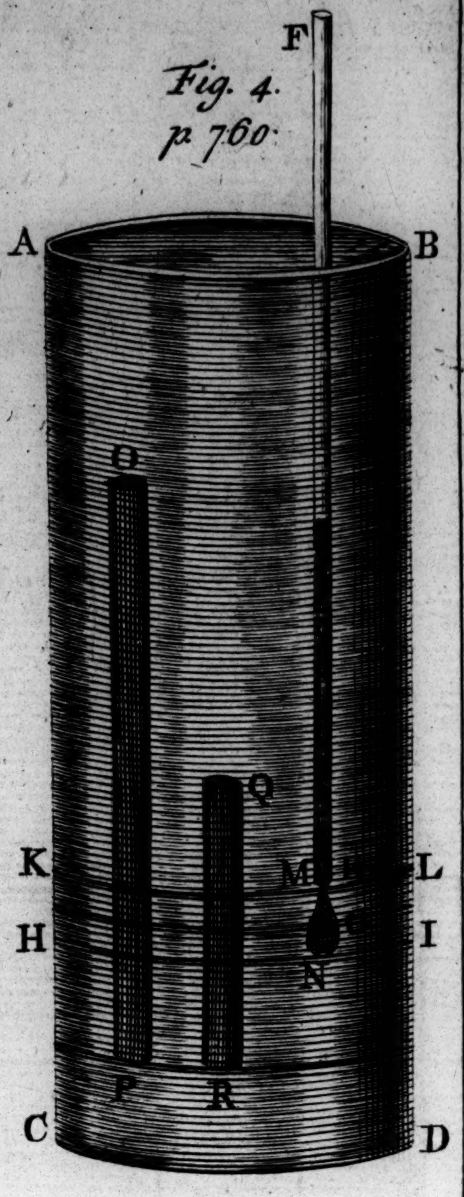
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Fig. 5. p. 763.

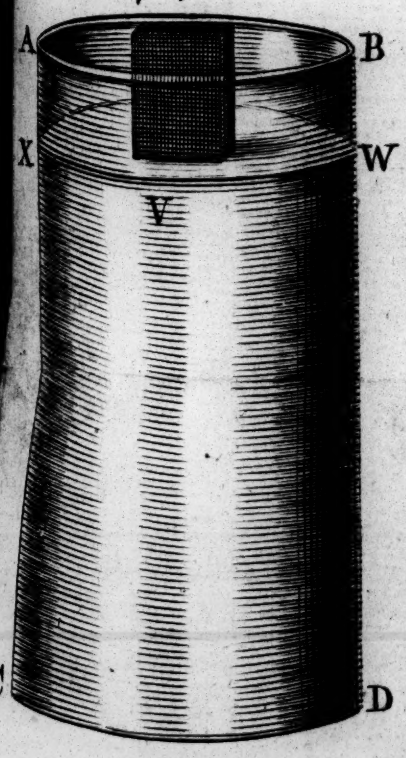

Fig. 6. p. 768.

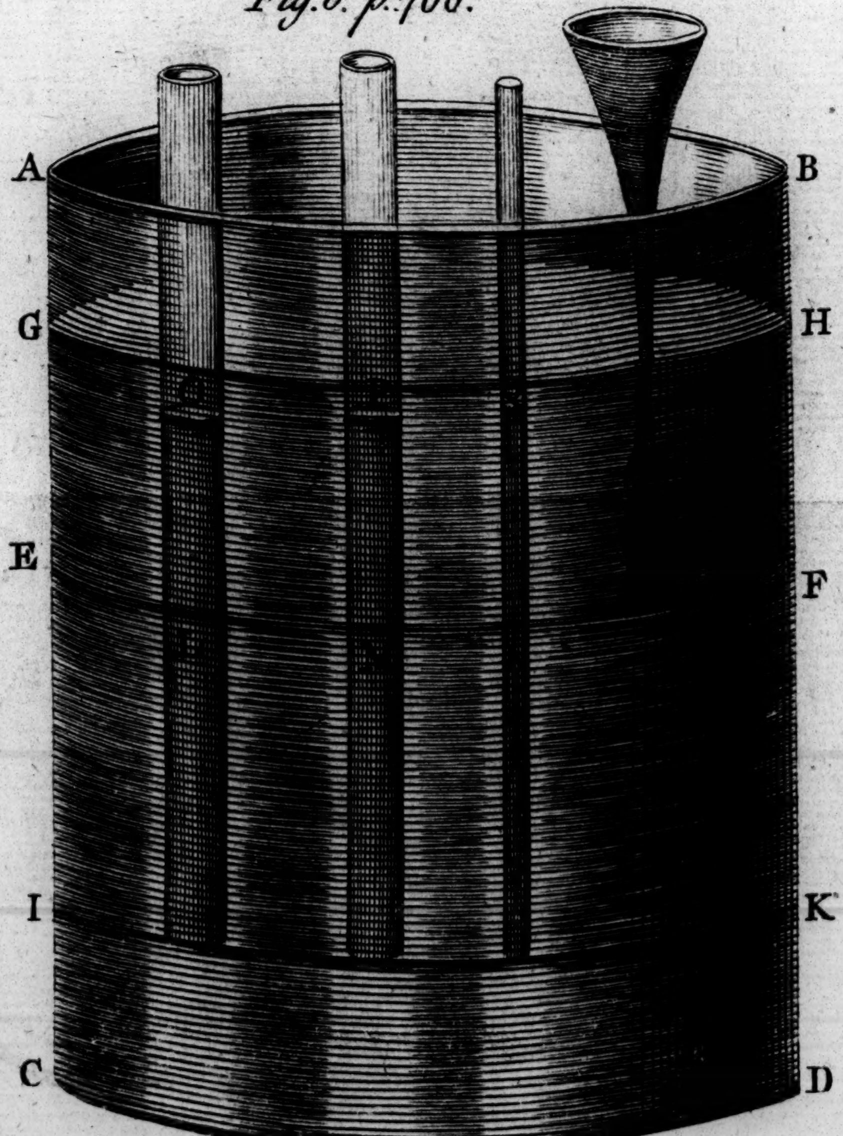
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Fig. 8. p. 771.

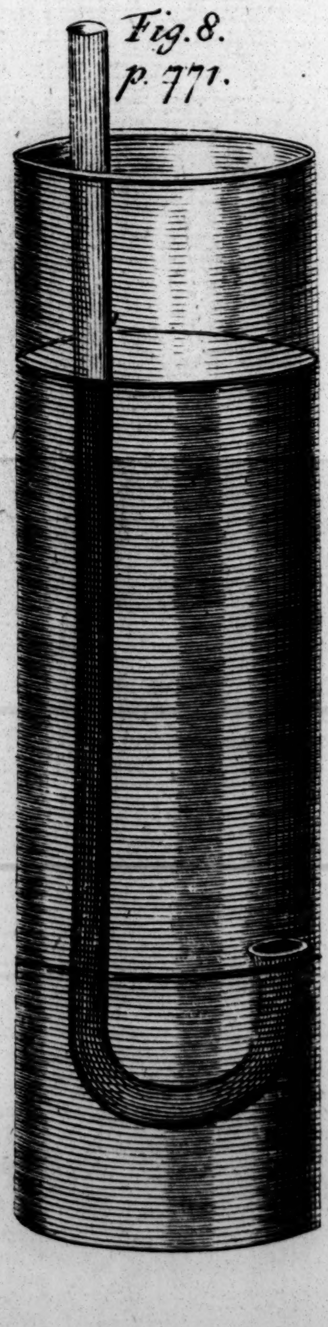
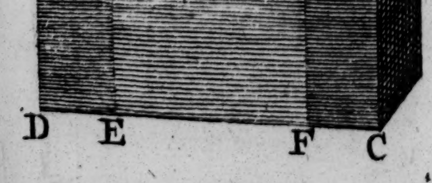


Fig. 7. p. 770.



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Q than any where elſe, the part Q, being unable to reſiſt ſo great a preſſure, muſt neceſſarily be thruſt out of place by the deſcending oil.

SECONDLY, This ſubſiding will continue but till the ſurface of the oil in the pipe be fallen almoſt as low, as that of the water without the pipe; becauſe then, and not before, the parts at Q are but as much preſſed by the oil, as the other parts of the ſurface G H are by the water, that leans upon them.

THIRDLY, It is a concluding circumſtance to our preſent purpoſe, that if, the oil and water being in an æquilibrium, you gently lift up the pipe, as from Q to S, the depth of the water being leſſened, the oil in the pipe will grow preponderant, and therefore will fall out in drops or globules; which, by the greater ſpecifick gravity of the water, will be buoyed up to the top of the liquor, and there float: and ſtill, as you lift up the pipe higher and higher towards the ſurface L M, more and more of the oil will run out. But if you ſtop the pipe any where in its aſcent, as at S, the efluxion of the oil will likewiſe be ſtopped. And at the imaginary ſuperficies I K, as by reaſon of the ſhallowneſs of the water from L to J, or M to K, the preſſure of the water upon the other parts of the ſurface is not near ſo great, as it was upon the ſurface G H, where the water had a greater depth; ſo, by reaſon of the proportionate efluxion of the oil, whilſt the pipe was lifted up from Q to S, the remaining cylinder of oil, incumbent on S, is not able to preſs that part of the ſuperficies I K more ſtrongly, than the other parts of the ſame ſuperficies are preſſed by the water incumbent on them. And if the pipe be lifted up, till the lower orifice be almoſt raiſed to V, that is, almoſt as high as the uppermoſt ſurface of the water L M, ſo much of the oil will, for the reaſon already given, run out, that there will ſcarce be any left in the pipe T V.

FOURTHLY, But if, when the pipe reſts at the ſurface G H, where the oil is in an æquilibrium with the water, you ſhould, inſtead of lifting it from Q to S, thruſt it down from Q to O; then the external water would not only ſuſtain the oil, but make it aſcend in the pipe to a height equal to the diſtance E G; and ſo the pipe will contain, beſides a longer cylinder of oil Æ W, a ſhorter one of water Æ O. For the pipe being transferred from the poſition P Q, to the poſition O N, there is a new imaginary ſurface E F, that paſſes by the lower orifice of the pipe. Now the part of this ſurface at O will not, by the incumbent oil alone, be preſſed as much as the other parts of the ſame ſurface are by the incumbent water. For the oil alone was but in æquilibrium with the water, when it was no deeper than L G, or H M; ſo that the other parts of the ſuperficies E F being more preſſed upon by the water, than the part at O by the oil, the oil muſt give place, and be buoyed up by the water, (which, if it were not for the weight of the oil, would be impelled up into the pipe full as high as the ſurface of the external water) till the preſſure of the admitted water O Æ, and the cylinder of oil Æ W, do both together gravitate as much upon the part O, as the reſt of the incumbent water does upon the other parts of the ſame ſuperficies E F.

FIFTHLY, and laſtly, It is very agreeable to what has been delivered, touching the æquilibrium of the oil and water in the pipe P Q, that the ſurface X, of the oil in the pipe, will not be of the ſame level with L M, that of the external water, but a little higher than it. For though the ſlenderneſs of the pipe do ſomewhat contribute to this effect, yet there would be an inequality, though not ſo great, betwixt theſe ſurfaces, upon this account; that oil of turpentine being *in ſpecie*, (as they ſpeak in the ſchools) that is, bulk for bulk, a lighter liquor than water, it is requiſite, that the height of it, incumbent on the part Q, be greater than that of the water on the other parts of the ſame ſurface G H, to make the preſſure of the oil, on the part it leans upon, equal to the preſſure of the water on the other parts of the ſurface. And if the inequality were greater betwixt the ſpecifick gravities of theſe two liquors, the inequalities betwixt the ſurface X and the ſurface L M would be alſo greater; as may be tried by ſubſtituting, for common water, oil of tartar *per deliquium*, which is a ſaline liquor much heavier than it. And that, in caſe the pipe contain not a lighter liquor than the external fluid, the ſurface of the liquor in the pipe will not be higher, than that of the liquor without it, we ſhall by and by have opportunity to manifeſt by experience.

FROM what has been hitherto ſhewn, we may ſafely infer the propoſition, upon whoſe occaſion all this has been delivered. For ſince the oil, in a pipe open at both ends, may be kept ſuſpended in any part under water, as at Q, becauſe it is there in an æquilibrium with the external water; and ſince, being lifted up in the water, as from Q to S, the oil can no longer be kept ſuſpended, but, by its own gravity, will run out: and ſince, in a word, the deeper the water is, the greater weight and preſſure is required in the cylinder of oil, to be able to countervail the preſſure of the water, and keep itſelf from being lifted up thereby; there ſeems no cauſe to doubt, but that the parts of the water incumbent on the ſuperficies G H do more preſs that ſuperficies, than the parts of the water contiguous to the ſuperficies J K do preſs that; and conſequently, that the parts of the water, that are under the uppermoſt ſurface of it, are preſſed by thoſe of the ſame fluid, that are directly over them. As we ſaw alſo, that the upper parts of the oil, whilſt the pipe was in raiſing from Q to S, depreſſed the lower ſo much, as to force them quite out of the pipe; there being, in theſe caſes, no reaſon, why the lowermoſt parts of a liquor ſhould preſs more, or have a ſtronger endeavour againſt any other liquor (or any other body) the higher the liquor incumbent reaches, if theſe inferiour parts derived their preſſure only from their own particular gravity, (which is no greater, than that of the other homogeneous parts of the liquor:) and therefore they muſt derive the great force, wherewith they preſs, from the weight of the incumbent parts, which, conſequently, muſt be allowed to preſs upon them.

BUT, before I proceed to the following propoſitions, it will not be amiſs to mention here, once for all, a few advertiſements, to avoid the neceſſity of repeating the ſame things in the ſequel of the diſcourſe.

AND firſt, What is here ſaid of the preſſure of the parts of water upon one another, and the other affections, that we ſhall attribute to it, in the following paper, are to be applied to heavy fluids in general, unleſs there ſhall appear ſome particular cauſe of excepting ſome of them in particular caſes.

SECONDLY, Whereas I lately intimated, that the inequality betwixt the ſurfaces of the oil in the pipe, and of the external water, was in part to be aſcribed to the ſlenderneſs of the pipe to be employed in theſe experiments; I did it for this cauſe, that, whatever the reaſon of it be, (which we need not here inquire after) we are aſſured by experience, as we have elſewhere ſhewn, that, when glaſs-pipes come to be ſlender, water, and many other liquors (though not quickſilver) will have within them a higher ſurface, than that of the ſame liquor without them; and this inequality of ſurfaces (as far as we have yet tried) increaſes with the ſlenderneſs of the pipe. But this, as to our preſent experiment, is a matter of ſo little moment, that it may ſuffice to have intimated, that we did not overſee it.

THIRDLY, Wherefore, notwithſtanding this little inconvenience of ſlender glaſſes, we think it expedient to employ ſuch in the following experiments, becauſe we found, that in thoſe of a wide bore, upon ſuch little inequalities of preſſure, as are not eaſily to be avoided, the oil and water will paſs by one another in the cavity of the pipe, and ſo ſpoil the experiment, which requires, that the oil within the pipe be kept in an intire and diſtinct body.

Fourthly, Common oil and water, or any other two liquors, that will not mingle, may ſerve the turn in moſt of theſe experiments; but we rather chuſe oil of turpentine, becauſe it is light and thin, clear and colourleſs, and may be eaſily had in quantities, and is not ſo apt to ſpot one's clothes, or obſtinately to adhere to the porous bodies it chances to fall on, as common, and other expreſſed oils. And for their ſakes to whom the odour is offenſive, we preſently correct it, by mingling with it a convenient quantity of oil of rhodium, or ſome other chymical oil, that is odoriferous.

Fifthly, Oil of turpentine, though it be not reckoned among the ſaline menſtruums, will yet (as we elſewhere note) work upon copper, and ſo by digeſting it upon crude filings of that metal, we obtain a deep green liquor, which may be made uſe of inſtead of the limpid oil, to make the diſtinction of the liquors more conſpicuous.

Sixthly, And for the ſame purpoſe we often uſe, inſtead of clear water, a ſtrong decoction of brazil, or log-wood, or elſe red ink itſelf: I ſay, a ſtrong decoction, becauſe unleſs the liquor be ſo deeply tinged, as to appear opacous in the glaſs, when it comes into the ſlender pipe, its colour will be ſo diluted, as to be ſcarce diſcernible.

Seventhly, In the ſhape of the glaſs-veſſel, we need not be curious; though that of a wide-mouthed jar, expreſſed in the ſcheme, be for ſome uſes more convenient than other ſhapes. The depth of theſe glaſſes, and the length of the pipes, muſt be determined by the experiments, about which one means to employ them. To make out the firſt paradox already proved, a glaſs of about five or ſix inches deep, and a pipe about as many inches long, will ſerve the turn: but for ſome others of the following experiments, tall cylindrical glaſſes will be requiſite; and for ſome, broad ones likewiſe will be expedient.

Eighthly, One muſt not be diſcouraged by not being able, at the firſt or ſecond time, to ſuck up oil of turpentine to the due height, and ſtop it with one's finger from relapſing; but one muſt try again, and again; eſpecially ſince many trials of this kind may be made in a few minutes; and for beginners it is a ſafe and good, though not the ſhorteſt way, to ſuck up rather more liquor than one judges will be needful; becauſe having filled the pipe to that height, you may, by letting in the air warily and ſlowly between the orifice of the glaſs and the pulp of your finger, ſuffer ſo much liquor to run out of the pipe, as will reduce it to the height you deſire; and there, by cloſe ſtopping the orifice with your finger, you may keep it ſuſpended as long as you pleaſe, and immerſe it into any heterogeneous liquor, and take it out again at pleaſure without ſpilling any of it. By which ſlight expedient alone, I can decline ſeveral difficulties, and do many things, which, according to Monſieur *Paſcal*'s way, require a great deal of trouble and apparatus to be performed.

Lastly, in ſuch experiments, where it may be of uſe, that there be a conſiderable diſparity betwixt the two unmingled liquors, we may (as is above intimated) inſtead of fair water, imploy *oleum tartari per deliquium*, and tinge it with brazil or cochineel; from either of which, but eſpecially from the latter, it will obtain an exceeding deep redneſs. And where one would avoid ſtrong ſcents and oilineſs, he may, if he will be at the charge, imploy oil of tartar *per deliquium*, inſtead of fair water; and highly rectified ſpirit of wine, inſtead of oil of turpentine. For theſe two liquors, though they will both readily mingle with water, will not with one another: and if a great quantity of ſome other liquor be to be ſubſtituted for ſimple water, when theſe chymical liquors are not to be had in plenty, one may imploy (as we have done) a very ſtrong ſolution made of ſea-ſalt, and filtred through cap-paper: this brine being near about as limpid as common water, and far heavier than it. And for a curioſity, we have added to the two lately mentioned liquors (oil of tartar, and ſpirit of wine) ſome oil of turpentine, and thereby had three liquors of different gravities, which will not by ſhaking be brought ſo to mingle, as not quickly to part again, and retire each within its own ſurface; and by thruſting a pipe with water in the bottom of it (placing alſo one's finger upon the upper orifice) beneath the ſurface of the lowermoſt of theſe liquors, and by opportunely raiſing or depreſſing it, one may ſomewhat vary the experiment in a way not unpleaſant, but explicable upon the ſame grounds with the reſt of the phænomena mentioned in this diſcourſe.

## PARADOX II.

### *That a lighter fluid may gravitate or weigh upon a heavier.*

I KNOW that this is contrary to the common opinion, not only of the ſchools, but even of divers hodiern mathematicians, and writers of Hydroſtaticks, ſome of whom have abſolutely rejected this paradox, though they do but doubt of the truth of the former.

BUT when I conſider, that whether the cauſe of gravity be the pulſion of any ſuperiour ſubſtance, or the magnetical attraction of the earth, or whatever elſe it be, there is in all heavy bodies, as ſuch, a conſtant tendency towards the center, or lowermoſt parts of the earth; I do not ſee, why that tendency or endeavour ſhould be deſtroyed by the interpoſition of any other heavy body; though what would otherwiſe be the effect of that endeavour, namely, an approach towards the center, may be hindred by another body, which being heavier than it, obtains by its greater gravity a lower place; but then the lighter body tending downwards, muſt needs preſs upon the heavier, that ſtands in its way, and muſt, together with that heavier, preſs upon whatever body it is, that ſupports them both, with a weight conſiſting of the united gravities of the more, and the leſs heavy body.

BUT that, which keeps learned men from acknowledging this truth, ſeems to be this, that a lighter liquor (or other body) being environed with a heavier, will not fall down, but emerge to the top: whence they conclude, that, in ſuch caſes, it is not to be conſidered as a heavy, but as a light body.

BUT to this I anſwer, that though in reſpect of the heavier liquor, the leſs heavy may, in ſome ſenſe, be ſaid to be light; yet notwithſtanding that relative or comparative levity, it retains all its abſolute gravity, tending downwards as ſtrongly as before; though, by a contrary and more potent endeavour upwards of the contiguous liquor (whoſe lower parts, if leſs reſiſted, are preſſed upwards by the higher, elſewhere incumbent; according to the doctrine partly delivered already, and partly to be cleared by the proof of the next propoſition) its endeavour downward is ſo ſurmounted, that it is forcibly carried up. Thus when a piece of ſome light wood being held under water, is let go, and ſuffered to emerge, though it be buoyed up by the water, whoſe ſpecifick gravity is greater, yet even whilſt it aſcends it remains a heavy body; ſo that the aggregate of the water, and the aſcending wood, weighs more than the water alone would do; and when it floats upon the upper part of the water, as part of it is extant above the ſurface, ſo part of it is immerſed beneath it, which confirms what we were ſaying, that a lighter body may gravitate upon a heavier.

And thus there is little doubt to be made, but that if a man ſtand in one of the ſcales of a balance with a heavy ſtone tied to his hand, and hanging freely by his ſide, if then he lift that weight as high above his head as he can, notwithſtanding that the ſtone's motion upwards makes it ſeem a light body, in reſpect of the man, whoſe body it leaves beneath it, yet it does not, either during its aſcent or after, loſe any thing of its connatural weight. For the man, that lifts it up, ſhall feel its tendency downwards to continue, though his force, being greater than that tendency, be able, notwithſtanding that tendency, to carry it up: and when it is aloft, it will ſo preſs againſt his hand, as to offend, if not alſo to bruiſe it; and the ſtone, and the man, that ſupports it, will weigh no leſs in the ſcale he ſtands in, than if he did not at all ſupport it, and they were both of them weighed apart.

Likewise, if you put into one ſcale a wide-mouthed glaſs full of water, and a good quantity of powdered common ſalt; and into the other ſcale a counterpoiſe to them both; you may obſerve, that, though at the beginning the ſalt will manifeſtly lie at the bottom, and afterwards by degrees be ſo taken up into the body of the liquor, that not a grain will appear there; yet nevertheleſs (as far as I can judge by my experiments) the weight in that ſcale will not be diminiſhed by the weight of as much ſalt as is inceſſantly either carried up, or ſupported by the reſtleſs motion of the diſſolving corpuſcles of the water; but both the one and the other, (allowing for what may evaporate) will concurrently gravitate upon the ſcale, that the glaſs containing them leans on.

But of this more elſewhere. Now to prove the propoſition, by the new method, we have propoſed to ourſelf, in this diſcourſe:

Take a ſlender glaſs-pipe, and having ſucked up into it fair water, to the height of three or four inches, ſtop nimbly the upper orifice with your finger, and immerſe the lower into a glaſs full of oil of turpentine, till the ſurface of the oil in the veſſel be ſomewhat higher than that of the water in the pipe: then removing your finger, though the pipe do thereby become open at both ends, the water will not fall down, being hindered by the preſſure of the oil of turpentine, as will be obvious to them, that have attentively conſidered the explication of the former paradox; there being but this difference between this experiment and that there explained, that here the water is in the pipe, and the oil in the veſſel, whereas there the oil was in the pipe, and the water in the veſſel. And if you either pour more oil into the glaſs, or thruſt the pipe deeper into the oil, you ſhall ſee that the water will be buoyed up towards the top of the pipe; that is, a heavier liquor will be lifted up by a lighter. And ſince, by the explication of the firſt propoſition, it appears, that the reaſon, why the liquor is in this caſe raiſed in the pipe, is the gravity of the liquor that raiſes it, we muſt allow, that a lighter liquor *in ſpecie* may by its gravity preſs againſt a heavier.

And it agrees very well with our explication, both of this, and of the firſt experiment; that as there, the ſurface of the oil in the pipe was always higher than that of the water without it, becauſe the oil being the lighter liquor, a greater height of it was required to make an æquilibrium; ſo in our preſent experiment the ſurface of the liquor in the pipe will always be lower than that of the oil without it. For in the imaginary plain E F, the cylinder of water J G, contained in the pipe J H, will, by reaſon of its greater gravity, preſs as much upon the part J, as the diſtilled oil (K E, J L) being a lighter liquor, can do upon the

See the ſecond figure.

other parts of the ſame ſuppoſed plain E F, though the oil reached to a greater height above it.

THIS ſecond paradox, we have hitherto been diſcourſing of, may be alſo proved by what we formerly delivered, to make out the truth of the third part of the lemma premiſed to theſe propoſitions.

BUT becauſe this and the former paradox are of importance, not only in themſelves, but to the reſt of this treatiſe, and are likely, in moſt readers, to meet with indiſpoſition enough to be received, I will ſubjoin in this place a couple of ſuch experiments, as will not, I hope, be unacceptable, that I deviſed, the one to confirm this ſecond paradox, and the other to prove the firſt.

SOME of the gentlemen now preſent may poſſibly remember, that about the end of the year, that preceded the two laſt, I brought into this place a certain new inſtrument of glaſs, whereby I made it appear, that the upper parts of water gravitate upon the lower; which I did, by ſinking a body, that was already under water, by pouring more water upon it.

BUT that experiment belonging to other papers, I ſhall here ſubſtitute another performed by an inſtrument, which, though it makes not ſo fine a ſhew, may be more eaſily provided, and will as well as that other (though you were pleaſed to command that from me) ſerve to make out the ſame truth; which I ſhall apply myſelf to do, as ſoon as I have, by an improvement of the expedient I am to propoſe, made good my late promiſe of confirming the ſecond paradox.

AND before I can well draw an argument from theſe experiments, for either of the propoſitions to be proved by them, I muſt briefly repeat what I have elſewhere delivered * already (on another occaſion) touching the cauſe of the ſinking of ſuch bubbles; namely, that the bubble X conſiſting of glaſs, which is heavier *in ſpecie* than water; and air, which is lighter *in ſpecie* than water; and, if you pleaſe, alſo of water itſelf, which is of the ſame ſpecifick gravity with water; as long as this whole aggregate of ſeveral bodies is lighter than an equal bulk of water, it will float; but in caſe it grows heavier than ſo much water, it muſt, according to the known laws of the hydroſtaticks, neceſſarily ſink, (being not otherwiſe ſupported.) Now when there is any competent preſſure (whether produced by weight or otherwiſe) upon the water, in which this bubble is for the moſt part immerſed, becauſe the glaſs is a firm body, and the water, though a liquor, either ſuffers no compreſſion, or but an inconſiderable one; the air included in the bubble, being a ſpringy and very compreſſible body, will be compelled to ſhrink, and thereby poſſeſſing leſs room than it did before, the contiguous water will ſucceed in its place; which being a body above a thouſand times heavier than air, the bubble will thereby become heavier than an equal bulk of water, and conſequently will ſink: but if that force or preſſure be removed, the impriſoned air will, by its own ſpring, free itſelf from the intruding water; and the aggregate of bodies, that makes up the bubble, being thereby grown lighter than an equal bulk of water, the ſubſided bubble will preſently emerge to the top. Fig. III.

THIS explication of the cauſes of the ſinking of bubbles agrees in ſome things with the doctrine of the learned Jeſuits *Kircher* and *Schottus*, and ſome other writers, in the account they give of thoſe two experiments, that are commonly known by the name, the one of the Roman, the other of the Florentine experiments. But there are alſo particulars, wherein I (who have never a recourſe to a *fuga vacui)* diſſent from their doctrine: the principles, I go upon, having invited and aſſiſted me to make that experiment, afford me ſome new phænomena, which agree not with their opinions, but do with mine: but I forbear to mention them here, becauſe they belong to other papers; and for the ſame reaſon I omit ſome acceſſion of ludicrous phænomena (as they call them) which I remember I have ſometimes added to thoſe, which our induſtrious authors have already deduced from thoſe experiments.

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* In certain notes upon ſome of the Phyſico-mechanical Experiments touching the air.

THESE things being premiſed, I proceed to the confirmation of the ſecond paradox, by the following experiment:

TAKE a long glaſs-pipe, ſealed, or otherwiſe exactly ſtopped at one end, and open at the other; (whoſe orifice, if it be no wider than that it may be conveniently ſtopped with a man's thumb, the tube will be the fitter to exhibit ſome other phænomena.) Into this pipe pour ſuch a quantity of common water, as that there may be a foot, or half a yard, or ſome other competent part left unfilled, for the uſe to be by and by mentioned. Then having poiſed a glaſs-bubble with a ſlender neck, in ſuch a manner, as that, though it will keep at the top of the water, yet a very little addition of weight will ſuffice to ſink it, put this bubble thus poiſed into the tube; where it will ſwim in the upper part of the water, as long as it is let alone; but if you gently pour oil of turpentine upon it, (I ſay gently, to avoid confounding the liquors) you will perceive, that, for a while, the bubble will continue where it was: but if you continue pouring on oil, till it have attained a ſufficient height above the water, (which it will be eaſy to perceive, becauſe thoſe two liquors will keep themſelves diſtinct) you ſhall ſee the bubble ſubſide, till it fall to the bottom, and continue there as long as the oil remains at the height above the water.

THE reaſon of this phænomenon, according to our doctrine, is this, that the oil of turpentine, though a lighter liquor than water, yet gravitates upon the ſubjacent water, and by its preſſure forces ſome of it into the cavity of the bubble at the open orifice of its neck, whereby the bubble, which was before but very little leſs heavy than an equal bulk of water, being by this acceſſion made a little more heavy, muſt neceſſarily ſink: and the cauſe of its ſubmerſion, namely the preſſure of the oil, continuing, it muſt remain at the bottom.

AND to confirm this explication, I ſhall add, that in caſe, by inclining the tube or otherwiſe, you remove the cylinder of oil, or a competent part of it, (in caſe it were longer than was neceſſary) the bubble will again emerge to the top of the water (for, as for the oil, that is too light a liquor to buoy it up) which happens only, becauſe the preſſure of the oil upon the water being taken off, the air, by virtue of its own ſpring, is able to recover its former expanſion, and reduce the bubble to be as light, as it was before.

AND now we may proceed to that other experiment, by which we lately promiſed to confirm the firſt paradox. And, in ſome regard, this following experiment has been preferred, as more ſtrange, to that I have been reciting; for it ſeemed much leſs improbable, that, of two heterogeneous liquors, the inferior ſhould be preſſed upon by the incumbent, which, though lighter, kept in an intire body above it; than that, in water, which is a homogeneous liquor, and whoſe parts mingle moſt freely and exquiſitely with one another, the upper part ſhould preſs upon the lower; and that they will do ſo, may appear by the experiment it is now time to ſubjoin.

PROVIDE a long tube, and a poiſed bubble, as in the former experiment; then, having poured water into the tube, till it reach above five or ſix inches (for a determinate height is no way neceſſary) above the bottom, caſt in the bubble, which will not only ſwim, but, if you thruſt it down into the water, it will of itſelf emerge to the upper part of it. Wherefore take a ſlender wand, or a wire, or a ſlender glaſs-pipe, or any ſuch body, that is long enough for your purpoſe, and, with it, having thruſt the bubble beneath the ſurface of the water, pour water ſlowly into the tube, (whoſe cavity will not be near filled by the rod, or wire) till it have attained a competent height, (which, in my laſt trials, was about a foot, or half a yard above the bubble) and you ſhall ſee, that the bubble, which before endeavoured to emerge, will, by the additional weight of the incumbent water, be depreſſed to the bottom of the tube. After which you may ſafely remove the wire, or other body, that kept it from riſing. For, as the weight of the incumbent water was that, which made it ſink, ſo, that weight continuing on it, the bubble will continue at the bottom.

BUT yet it is not without cauſe, that we employ a wire, or ſome ſuch thing, in this experiment, though we affirm it to be only the weight of the incumbent water, that makes the bubble ſink. For if you ſhould pour water into the tube to the height lately mentioned, or even to a greater, if you did not make uſe of the wire, it would not ſerve the turn; becauſe that, as faſt as you pour in the water, the bubble, being left to itſelf, will riſe together with it; and ſo, keeping always near the upper part of the water, it will never ſuffer the liquor to be ſo high above it, as it muſt be, before it can depreſs it. But to confirm, that it is the weight of the ſuperiour water, that ſinks the bubble, and keeps it at the bottom; if you take out of the tube a competent quantity of that liquor, and ſo take off the preſſure of it from the bubble, this will preſently, without any other help, begin to ſwim, and regain the upper part of the water; whence it may at pleaſure be precipitated, by pouring back into the tube the water, that was taken out of it. And theſe confirmations, added to the former proofs of the firſt and ſecond paradoxes, being, we conceive, ſufficient to ſatisfy impartial readers of the truth of them, we ſhould preſently advance to the next propoſition, if we did not think fit to interpoſe here a ſcholium.

### SCHOLIUM.

IT may, perchance, be wondered at, why, ſince we lately mentioned our having made ſome trials with oil of tartar *per deliquium*, we did not, in the preſent experiment, inſtead of fair water, make uſe of that, it being a very much heavier liquor, and (though it may be incorporated with expreſſed oils) unmingleable, in ſuch trials, with oil of turpentine. But to this I anſwer; that, even in ſuch ſlender pipes, as thoſe made uſe of about the firſt experiment, I found, that oil of tartar was ponderous enough to flow down, though ſlowly, into the oil of turpentine at one ſide of the immerſed orifice, whilſt the oil paſſed upwards by it along the other ſide of the pipe. And my knowledge of this could not but make me a little wonder, that ſo curious a perſon, as Monſieur *Paſcal*, ſhould ſomewhere teach, that, if a tube of above fourteen foot long, and having its orifice placed fourteen foot under water, be full of quickſilver, the fluid metal will not all run out at the bottom of the pipe, though the top of it be left open to the air, but will be ſtopped at a foot high in the pipe. For the impetus, that its fall will give it, muſt probably make it flow quite out of the pipe: and, not here to mention thoſe trials of ours with quickſilver and ſlender tubes, that made me think this very improbable, if we conſider, that the experiment will not ſucceed, with much more favourable circumſtances, betwixt oil of turpentine and oil of tartar, though the heavier of theſe two liquors be many times lighter than quickſilver; it tempts me much to ſuſpect, that Monſieur *Paſcal* never actually made the experiment, at leaſt with a tube as big as his ſcheme would make one gueſs; but yet thought he might ſafely ſet it down, it being very conſequent to thoſe principles, of whoſe truth he was fully perſuaded. And indeed, were it not for the impetus, the quick-ſilver would acquire in falling from ſuch a height, the ratiocination were no way unworthy of him.

BUT experiments, that are but ſpeculatively true, ſhould be propoſed as ſuch, and may oftentimes fail in practice; becauſe there may intervene divers other things capable of making them miſcarry, which are overlooked by the ſpeculator, that is wont to compute only the conſequences of that particular thing, which he principally conſiders; as, in this caſe, our author ſeems not to have conſidered, that in ſuch tubes, as the Torricellian experiment is wont to be made in, the largeneſs of them would make them unfit for this trial.

AND I have known ingenious men, that are very well exerciſed in making ſuch experiments, complain, that they could never make this of Monſieur *Paſcal's* to ſucceed. In which attempts, that the ſize of the tubes much contributed to the unſucceſsfulneſs of the trials, I ſhall, without repeating what has been already intimated to that purpoſe, in the following part of this diſcourſe have opportunity to manifeſt; and, withal, to add as illuſtrious a proof of this our ſecond paradox, as almoſt any we have yet given.

## PARADOX III.

*That if a body contiguous to the water be altogether, or in part, lower than the higheſt level of the ſaid water, the lower part of the body will be preſſed upward by the water, that touches it beneath.*

THIS may be proved by what has been already delivered in the explication of the firſt experiment: for, where-ever we conceive the loweſt part of the body, which is either totally, or in part, immerſed in water, to be, there the imaginary ſuperficies being beneath the true ſuperficies, every part of that imaginary ſuperficies muſt be preſſed upwards, by virtue of the weight of the water incumbent on all the other parts of the ſame ſuperficies; and ſo that part of it, on which the immerſed body chances to lean, muſt, for the ſame reaſon, have an endeavour upwards. And if that endeavour be ſtronger than that, wherewith the weight of the body tends downwards, then (ſuppoſing there be no accidental impediment) the body will be buoyed, or lifted up. And though the body be heavier than ſo much water, and conſequently will ſubſide, yet that endeavour upwards of the water, that touches its lower part, is only rendered ineffectual to the raiſing, or ſupporting the body, but not deſtroyed; the force of the heavy body being from time to time reſiſted, and retarded by the water, as much as it would be, if that body were put into one ſcale, and the weight of as much water, as is equal to it in bulk, were put into the other.

To confirm this, we may have recourſe to what we ſaid in the explication of the ſecond experiment. For in caſe the ſlender pipe, wherein the water is kept ſuſpended, be thruſt deeper into the oil; or in caſe there be more oil poured into the veſſel, the water will be impelled up higher into the pipe; which it would not be, if the oil, though bulk for bulk a lighter body, did not preſs againſt the lower ſurface of the water, (where alone the two liquors are contiguous) more forcibly than the water, by its gravity, tends downwards. And, even when the liquors reſt in an æquilibrium, the oil continually preſſes upwards againſt the lower ſurface of the water; ſince in that continual endeavour upwards conſiſts its conſtant reſiſtance to the continual endeavour, that the gravity of the water gives it to deſcend. And ſince the ſame phænomenon happens, whether we ſuſpend water in oil, as in the ſecond experiment, or oil in water, as in the firſt; it appears, that the propoſition is as well applicable Fig. I. II.

to thoſe caſes, where the ſuſtained body is ſpecifically heavier, as to thoſe, where it is ſpecifically lighter, than the ſubjacent fluid.

BUT a further and clearer proof of this doctrine will appear in the explication of the next propoſition. In the mean time, to confirm that part of our diſcourſe, where we mentioned the reſiſtance made by the water to bodies that ſink in it, let us ſuppoſe, in the annexed figure, that the pipe E F contains an oil ſpecifically heavier than water, (as are the oils of guaiacum, of cinnamon, or cloves, and ſome others) and then, that the oil in the pipe, and the water without, being at reſt in an æquilibrium, the pipe be ſlowly raiſed towards the top of the veſſel: it is evident, from our former doctrine, and from experience too, that there will run out drops of oil, which will fall from the bottom of the pipe to that of the veſſel; but far more ſlowly, than if they fell out of the ſame pipe in the air. Fig. IV.

NOW, to compute, how much the preſſure of the water againſt the lower parts of the drop amounts to, let us ſuppoſe the drop to be G, to whoſe lowermoſt part there is contiguous, in any aſſignable place, where it falls, the imaginary ſuperficies H J. It is evident, that, if the drop of oil were not there, its place would be ſupplied by an equal bulk of water; which being of the ſame ſpecifick gravity with the reſt of the water in the veſſel, the ſurface H J would be laden every where alike; and conſequently no part of it would be diſplaced. But now, the drop of oil being heavier than ſo much water, that part of the imaginary ſuperficies, on which that drop leans, has more weight upon it, than any other equal part of the ſame ſuperficies; and conſequently will give place to the deſcending drop. And ſince the caſe of every other ſuppoſed ſurface, at which the drop can be conceived to arrive in its deſcent, will be the ſame with that of the ſuperficies H J; it will, for the reaſon newly given, continue falling, till it comes to the bottom of the veſſel, which will ſuffer it to fall no further. And in caſe the drop G were not, as we ſuppoſe it, of a ſubſtance heavier *in ſpecie* than water, but juſt equal to it, the contiguous part of the ſuperficies H J would be neither more nor leſs charged, than the other parts of the ſame ſuperficies; and the part leaned on would be neither depreſſed nor raiſed, but the drop G would continue in the ſame place. And ſo we may prove, (what is affirmed by *Archimedes*, and other hydroſtatical writers) that a body, equiponderant *in ſpecie* to water, will reſt in any aſſignable place of the water, where it is put.

AND (to proceed further) ſince, if the drop G were of a matter but equiponderant to water, it would not ſink lower at all, no more than emerge; it follows, that though, being heavier *in ſpecie* than water, yet the gravity, upon whoſe account it falls, is no more than that, by which it ſurmounts an equal bulk of water; (ſince, if it were not for that overplus, the reſiſtance of the water would hinder it from falling at all) and conſequently, it loſes in the water juſt as much of the weight it would have in the air, as ſo much water, weighed likewiſe in the ſame air, would amount to.

WHICH is a phyſical account of that grand theorem of the Hydroſtaticks, which I do not remember that I have ſeen made out in any printed book, both ſolidly and clearly; the learned *Stevinus* himſelf, to whom the later writers are wont to refer, having but an obſcure, and not phyſical, demonſtration of it.

AND, becauſe this theorem is not only very noble, but, as we elſewhere manifeſt, very uſeful, it will not be amiſs to add, that it may eaſily be confirmed by experiment.

FOR, if you take (for inſtance) a piece of lead, and hang it by a horſe-hair (that being ſuppoſed very near equiponderant to water) from one of the ſcales of an exact balance; and, when you have put a juſt counterpoiſe in the other ſcale, ſuffer the lead to ſink in a veſſel of water, till it be perfectly covered with it, but hangs freely in it, the counterpoiſe will very much preponderate. And, part of the counterpoiſe being taken out, till the balance be again reduced to an æquilibrium, you may eaſily, by ſubducting what you have taken out, and comparing it with the whole weight of the lead in the air, find what part of its weight it loſes in the water. And then, if you weigh any other piece of the ſame lead, ſuppoſe a lump of twelve ounces, and hang it by a horſe-hair at one ſcale, you may be ſure, that, by putting into the other ſcale a weight leſs by a twelfth part, (ſuppoſing lead to water to be as twelve to one) that is, eleven ounces, though the weights be far from an æquilibrium in the air, they will be reduced to it, when the lead is covered with water.

THE preſſure of water againſt the lower part of the body immerſed in it may be confirmed by adding, that we may thence deduce the cauſe of the emergency of wood, and other bodies lighter than water; which though a familiar effect, I have not found its cauſe to have been ſo much as inquired into by many, nor, perhaps, to have been well rendered by any. If we ſuppoſe then, that the pipe be almoſt filled, not with a ſinking, but a ſwimming oil, as oil of turpentine, if, as in the firſt experiment, the lower orifice be thruſt under water (to a far leſs depth, than that of the oil in the pipe) and the upper be ſlowly unſtopped, the oil will, as we formerly declared, get out in drops at the bottom of the pipe. But to determine, why theſe drops, being quite covered and ſurrounded with water, and preſſed by it as well downwards as upwards, ſhould rather emerge than deſcend, I ſhall not content myſelf to ſay, that water *in ſpecie* is heavier than this kind of oil: for, beſides that, in ſome caſes, ere long to be mentioned, I have made the water to depreſs even this kind of oil, and beſides that, it is not every piece of wood, lighter *in ſpecie* than water, that will float upon water, how ſhallow ſoever it be; the queſtion is, how this prepollent gravity of the water comes to raiſe up the oil, though there be, perchance, much more water, for it to break its way thorough, above it, than beneath it.

THE reaſon then of the emerſion of lighter bodies in heavier fluids ſeems to be this, that the endeavour upwards of the water, contiguous to the lower part of the body, is ſtronger than the endeavour downwards of the ſame body, and the water incumbent on it. As, in the former ſcheme, ſuppoſing the drop G to be the oil of turpentine, and to touch the two imaginary and parallel plains H J, K L; it is evident, that upon the lower part of the drop N, there is a greater preſſure of water, than upon the upper part of the ſame drop, M: becauſe, that upon all the ſurface K L, there is but an uniform, preſſure of water A K B L, and upon all the parts of the ſurface H I, there is a greater weight of water A H B I, except at the part N; for there the oil G, being not ſo heavy as ſo much water, the oil being expoſed to a greater preſſure from beneath, than its own gravity (and that of the water incumbent on it) will enable it to reſiſt, muſt neceſſarily give way, and be impelled upward. And the caſe being the ſame between that and any other parallel plain, whereſoever we ſuppoſe it to be in its aſcent, it muſt conſequently be impelled further and further upwards, till it arrive at the top; and there it will float upon the water. Or, (to explicate the matter without figures) when a ſpecifically lighter body is immerſed under water, it is preſſed againſt by two pillars of water; the one bearing againſt the upper, and the other againſt the lower part: and becauſe the lengths of both theſe pillars muſt be computed from the top of the water, the lower part of the immerſed body muſt be preſſed upon by a pillar longer than the upper part by the thickneſs of the immerſed body; and conſequently muſt be preſſed more upwards than downwards.

wards. And by how much the greater diſparity of ſpecifick gravity there is betwixt the water and the emerging body, by ſo much the ſwifter (*cæteris paribus*) it will aſcend: becauſe ſo much the more will there be of preſſure upon all the other imaginary ſurface, than upon that part, that happens to be contiguous to the bottom of the aſcending body.

AND upon the ſame grounds we may give (what we have not yet met with) a good ſolution of that problem, propoſed by hydroſtatical writers, Why, if a cylindrical ſtick be cut in two parts, the one as long again as the other, and both of them, having been detained under water at the ſame depth, be let go at the ſame time, and permitted to emerge, the greater will riſe faſter than the leſſer. For ſuppoſe one of theſe bodies, as O P, to be two foot high, and the other, Q R, to be half ſo much, and that the lowermoſt ſurfaces of both be in the ſame imaginary plain, parallel to the uppermoſt ſurface of the water, and three foot diſtant from it; in this caſe there will be againſt the lower part of each of the wooden bodies a preſſure, (from the laterally ſuperiour water) equal to that upon all the other parts of the imaginary plain, whereto thoſe bodies are contiguous. But whereas upon the upper ſurface of the ſhorter body, Q R, there will lean a pillar of water two foot high, the pillar of the ſame liquor, that will lean upon the top of the taller body, P O, will be but one foot high; as the attentive conſiderer will eaſily perceive. So that the wooden bodies being lighter *in ſpecie* than water, both of them will be impelled upwards: but that compounded pillar (if I may ſo call it) which conſiſts of one foot of wood, and two foot of water, will, by its gravity, more reſiſt the being raiſed, than that which conſiſts of two foot of wood, and but one foot of water: ſo that the cauſe of the unequal celerity in the aſcenſion of theſe bodies conſiſts chiefly, (for I would neither overvalue nor exclude concomitant cauſes) that the difference of the preſſure againſt the upper and lower part of each body reſpectively is greater in one than in the other.

AND hence we may probably deduce a reaſon of what we often obſerve in the diſtillation of the oils of aniſeeds, cloves, and divers aromatick vegetables, in lembecks, by the intervention of water: for oftentimes when the fire has not been well regulated, there will come over, beſides the floating oil, a whitiſh water, which will not in a long time become clear. And as we have elſewhere taught that whiteneſs to proceed from the numerous reflections from the oily ſubſtance of the concrete, by the heat of the fire broken into innumerable little globules, and diſperſed through the body of the water; ſo the reaſon, why this whiteneſs continues ſo long, ſeems to be chiefly (for I mention not ſuch things, as, the great ſurfaces, that theſe little globules have in reſpect of their bulk) that, becauſe of the exceeding minuteneſs of theſe drops, the height of the water, that preſſes upon the upper part, is almoſt equal to that of the water, that preſſes againſt the lower part. So that the difference between theſe two preſſures being inconſiderable, it has power to raiſe the drops but very ſlowly, (inſomuch, that upon this ground I deviſed a menſtruum, wherewith I could mingle oil in drops ſo exceedingly minute, that even when there were but a few ſpoonfuls of the mixture, it would continue whitiſh for divers whole days together) though at length they will emerge; and the ſooner, becauſe, whilſt they ſwim up and down, as they frequently chance to meet and run into one another, they compoſe greater drops; which are (for the reaſon already given) leſs ſlowly impelled up by the water; at the top of which, the chymiſt, after a due time, is wont to find new oil floating. But whether this be any way applicable to the ſwimming of the inſenſible particles of corroded metals in aqua fortis, and other ſaline menſtruums, I muſt not now ſtay to inquire.

Fig. V.

One thing more there is, that I would point at, before I diſmiſs this paradox; namely, that, for the ſame reaſon we have all this while deduced, when the emergent drop, or any other body, floats upon the top of the water, it will ſink juſt ſo far, (and no farther) till the immerſed part of the floating body be equal in bulk to as much water as is equal in weight to the whole body. For ſuppoſe, in the annexed figure, Y to be a cube of wood three foot high, and ſix pound in weight; this wood, being much heavier than air, will ſink into the water, till it come to an imaginary ſuperficies, X W, where, having the poſition newly deſcribed, it will neceſſarily acquieſce. For all the other equal parts of the ſuperficies, X, W, Q, being leaned upon by pillars of water equal in height to the part X A, or W B, if the whole weight of the wooden cube be greater than that of as much water, as is equal to the immerſed part, it muſt neceſſarily ſink lower, becauſe the ſubjacent part of the ſurface (at V) will be more charged than any of the reſt. And, on the other ſide, if the cube were lighter than as much water as that, whoſe place the immerſed part takes up; it muſt, by the greater preſſure of the water upon the other parts of the imaginary ſuperficies, X W, than upon that contiguous to the wood, (as at V) be impelled upward, till the preſſure of the whole wood upon the part it leans on, be of the ſame degree with that of the reſt of the water, upon the reſt of the ſuperficies; and conſequently be the ſame with the water, whoſe place the immerſed part of it takes up; the lightneſs of that immerſed part, in reſpect of ſo much water, being recompenſed by the weight of the unimmerſed part, which is extant above the ſuperficies of the water. And we ſee, that when a piece of wood falls into water, though, by the impetus it acquires in falling, it paſſes through divers imaginary plains, that lie beneath its due ſtation; yet the greater preſſure, to which each of thoſe plains is expoſed in all its other parts, than in that, which is contiguous to the bottom of the wood, does quickly impel it up again, till, after ſome emerſions and ſubſidings, it reſts at length in ſuch a poſition, as the newly explicated hydroſtatical theorem aſſigns it.

## SCHOLIUM.

THIS ingenious propoſition (about floating bodies) is taught and proved, after the manner of mathematicians, by the moſt ſubtle *Archimedes*, and his commentators; and we have newly been endeavouring to manifeſt the phyſical reaſon, why it muſt be true. But partly becauſe the propoſition ought to hold, not only in ſuch intire and homogeneous bodies as men exemplify it in, (ſuch as a piece of wood, or a lump of wax) but in all bodies, though of a concave figure, and made up of many bodies of never ſo differing natures; (and perhaps ſome of them joined together only by their ſuperincumbency upon one another) and partly, becauſe that a truth, which is one of the main and uſefulleſt of the Hydroſtaticks, and may be of ſo much importance to navigation, has not yet (that I know of) been attempted to be demonſtrated, otherwiſe than upon paper; it will not be amiſs, for the ſatisfaction of ſuch of thoſe, whom it may concern, as are not verſed in mathematical demonſtrations, to add an experiment, which I made to prove it mechanically, as exactly as is neceſſary for the ſatisfaction of ſuch perſons.

After, then, having imployed ſeveral veſſels, ſome of wood, ſome of latten, and ſome of other materials, to compaſs what I deſired; we found glaſſes to be the moſt commodious we could procure. And therefore, filling a large and deep glaſs to a convenient height with fair water, we placed in it another deeper glaſs, ſhaped like a goblet or tumbler, that it might be the fitter for ſwimming; and having furniſhed it firſt with ballaſt, and then, for merriment ſake, with a wooden deck, by which a tall maſt, with a ſail faſtned to it, was kept upright; we fraughted with wood, and by degrees poured ſand into it, till we had made it ſink juſt to the tops of certain conſpicuous marks, that we had faſtned on the outſide of the glaſs, to oppoſite parts thereof. Then obſerving, how high the water reached in the larger glaſs, (which, by reaſon of the veſſel's tranſparency, was to be ſeen) we carefully placed two or three marks in the ſame level with the horizontal ſurface of the water; and taking out the floating veſſel as it was, with all that belonged to it, and wiping the outſide dry, we put it into a good pair of ſcales, and having found what it amounted to, we weighed in a competently large phial (firſt counterpoiſed apart) ſo much water, (to a grain, or thereabouts) and pouring this water into the large glaſs above mentioned, we found it to reach to the marks, that we had faſtned to the outſide of the glaſs, and conſequently to reach to the ſame height, to which the weight of the floating glaſs, and all that was added to make it reſemble a ſhip, had made it ariſe to. By which experiment (which we tried, as to the eſſential parts of it, with veſſels of differing ſizes, ſhapes, and ladings too, as wood, ſtone, quickſilver, *&c.*) it appears, that the floating veſſel itſelf, with all that was in it, or ſupported by it, was equal in weight to as much water as was equal in bulk to that part of the veſſel, which was under water, ſuppoſed to be cut off from the extant part of the ſame veſſel, by a plain continuing the horizontal ſurface of the water: ſince the weight of the floating veſſel, which raiſed up the water in the larger veſſel to the greateſt height it attained, was the ſame with the weight of the water, which being poured into the larger veſſel (when the other was taken out) raiſed the water therein to the ſame height. We may alſo obtain the ſame end, by a ſomewhat differing way, (which is the beſt way, in caſe the veſſels be too great) *viz.* to obſerve, firſt, by pouring in water out of a bowl or pail, or other veſſel of known capacity, as often as is neceſſary to fill the great veſſel, or ciſtern, or pond, to the top, (or to any determinate height required) and, next, letting out, or otherwiſe removing all that water, to put in its place the veſſel, whoſe weight is to be found out. Thirdly, to let, or pour in water, till the veſſel be afloat, and by its weight raiſe the external water to the height it had before. And laſtly, to examine, how much this water, that was laſt poured in, falls ſhort in weight of the water, that was in it at firſt, and afterwards removed. For this difference will give us the weight of as much water, as is equiponderate to the whole floating veſſel, whether ſmall or great, with all that it either carries or ſuſtains. The hydroſtatical theorem we have been conſidering, and the experiments, whereby we have endeavoured to confirm or illuſtrate it, may *(mutatis mutandis)* be applied to a ſhip with all her ballaſt, lading, guns, and company; it holding generally true, *That* (to expreſs the ſenſe of the propoſition more briefly) *the weight of a floating body is equal to as much water, as its immerſed part takes up the room of.* Whence we might draw ſome arguments in favour of the learned *Stevinus*, (for whoſe ſake it partly was, that I annexed this ſcholium) who, if I miſremember not, does ſomewhere deduce as a corollary from certain hydroſtatical propoſitions, that a whole ſhip, and all that belongs to it, and leans upon it, preſſes no more nor leſs upon the bottom it ſwims over, than as much water, as is equal in bulk to that part of the ſhip, which is beneath the ſurface of the water.

See paradox the ſixth.

## PARADOX IV.

*That in the aſcenſion of water in pumps,* &c. *there needs nothing to raiſe the water, but a competent weight of an external fluid.*

THIS propoſition may be eaſily enough deduced from the already mentioned experiments. But yet, for further illuſtration and proof, we will add that, which follows.

TAKE a ſlender glaſs-pipe, (ſuch as was uſed about the firſt experiment) and ſuck into it about the height of an inch of deeply tinĉted water; and, nimbly ſtopping the upper orifice, immerſe the lower part of the pipe into a glaſs half filled with ſuch tinĉted water, till the ſurface of the liquor in the pipe be an inch (or as low as you would have it) beneath that of the external water. Then pouring on oil of turpentine, till it ſwim three or four inches, or as high as you pleaſe above the water; looſen gently your finger from the upper orifice of the pipe, to give the incloſed air a little intercourſe with the external; and you ſhall ſee the tinĉted water in the pipe to be impelled up, not only higher than the ſurface of the external water, but almoſt as high as that of the external oil, through which (it being tranſparent and colourleſs) the red liquor may be eaſily diſcerned.

Now in this caſe it cannot be pretended, that the aſcent of the water in the pipe proceeds from nature's abhorrency of a vacuum; ſince the pipe being full of air, and its orifice unſtopped, though the water ſhould not aſcend, no danger of a vacuum would enſue; the air and the water remaining contiguous as before.

THE true reaſon, then, of the aſcent of the water, in our caſe, is but this; that upon all the other parts of the imaginary ſuperficies, that paſſes by the immerſed orifice of the pipe, there is a preſſure partly of water, and partly of the oil ſwimming upon that water, amounting to the preſſure of four or five inches of water; whereas upon that part of the ſame ſuperficies, whereon the liquor contained in the pipe leans, there is but the preſſure of one inch of water: ſo that the parts near the immerſed orifice muſt neceſſarily be thruſt out of place by the other parts of water, that are more preſſed; till ſo much liquor be impelled up into the pipe, as makes the preſſure on that part of the imaginary ſuperficies as great, as that of the oil and water on any other equal part of it. And then, by virtue of the æquilibrium, (often mentioned) the water will riſe no further; and, by virtue of the ſame æquilibrium, it will reſt a little beneath the ſurface of the external oil, becauſe this laſt named liquor is leſs heavy, bulk for bulk, than water.

AND by this we may be aſſiſted to give a reaſon of the aſcenſion of water in ordinary ſucking pumps. For as the oil of turpentine, though a lighter liquor than water, and not mingleable with it, does, by leaning upon the ſurface of the external water, preſs up the water within the pipe, to a far greater height than that of the external water itſelf; ſo the air, which, though a far lighter liquor than oil of turpentine, reaches I know not how many miles high, leaning upon the ſurface of the water in a well, would preſs it up into the cylindrical cavity of the pump, much higher than the external water itſelf reaches in the well, if it were not hindered.

Now that, which hinders it in the pump, is either the ſucker, which fences the water in the pump from the preſſure of the external air, or that preſſure itſelf. And therefore, all that the drawing up of the ſucker needs to do, is, to free the water in the pipe from the impediment to its aſcent, which was given it by the ſucker's leaning on it, or the pillar of the atmoſphere's being incumbent on it; as in our experiment, the ſides of the pipe do ſufficiently protect the water in the pipe from any preſſure of the external oil, that may oppoſe its aſcent.

And laſtly, as the water in our pipe was impelled up ſo high, and no higher, that the cylinder of water in the pipe was juſt able to balance the preſſure of the water and oil without the pipe; ſo in pumps, the water does riſe about thirty three or thirty four foot: and though you pump never ſo long, it will be raiſed no higher; becauſe at that height the preſſure of the water in the pump, upon that part of the imaginary ſuperficies, that paſſes by the lower orifice of it, is the ſame with the preſſure, which other parts of that imaginary ſuperficies ſuſtain from as much of the external water, and of the atmoſphere, as come to lean upon it.

That there may be caſes, wherein water may be raiſed by ſuction, not upon the account of the weight of the air, but of its ſpring, I have elſewhere ſhown; and having likewiſe in other places endeavoured to explicate more particularly the aſcenſion of water in pumps; what has been ſaid already may ſuffice to be ſaid in this place, where it is ſufficient for me to have ſhewn, that, whether or no the aſcenſion of water *may have* other cauſes, yet, in the caſes propoſed, it ***needs*** no more than the competent weight of an external fluid, as is the air; whoſe not being devoid of gravity, the cogency of our experiments has brought even our adverſaries to grant us.

For confirmation of this, I will here add, becauſe it now comes into my mind, (what might, perhaps, be elſewhere ſomewhat more properly mentioned) an experiment, that I did but lightly glance at in the explication of the firſt, and the ſcholium of the ſecond paradox.

In order to this, I muſt advertiſe, that, whereas I there took notice, that ſome ingenious men had complained, that, contrary to the experiment propoſed by Monſieur *Paſcal*, they were not at all able to keep mercury ſuſpended in tubes, however very ſlender, though the lower end were deeply immerſed in water, if both their ends were open; the reaſons of my doubting, whether our ingenious author had ever made, or ſeen the experiment, were not only, that it had been unſucceſsfully tried, and ſeemed to me unlikely to ſucceed in tubes more ſlender, than his appeared; but, becauſe the impetus, which falling quickſilver gains by the acceleration of motion it acquires in its deſcent, muſt, in all probability, be great enough to make it all run out at the bottom of a tube open at both ends, and filled with ſo ponderous a liquor, though the tube were very much ſhorter, than that propoſed by Monſieur *Paſcal*.

This advertiſement I premiſe, to intimate, that, notwithſtanding the hopeleſſneſs of the experiment, as it had been propoſed and tried, I might have reaſon not to think it impoſſible to perform, by another way, the main thing deſired; which was, to keep quickſilver ſuſpended in a tube, open at both ends, by the reſiſtance of the ſubjacent water. For, by the expedient I am going to propoſe, I have been able to do it, even with a liquor much lighter than water.

Finding then, that even a very ſhort cylinder of ſo ponderous a fluid as mercury, would, if it were once in falling, deſcend with an impetus not eaſy to be reſiſted by the ſubjacent liquor, I thought upon the following expedient to prevent this inconvenience. I took a ſlender pipe, the diameter of whoſe cavity was little above the ſixth part of an inch; and having ſucked in, at the lower end of it, ſomewhat leſs than half an inch of quickſilver, and nimbly ſtopped the upper orifice with my finger, I thruſt the quickſilver into a deep glaſs of oil of turpentine, with a care not to unſtop the upper orifice, till the ſmall cylinder of quickſilver was eighteen or twenty times its depth beneath the ſurface of the oil. For by this means, when I unſtopped the pipe, the quickſilver needed not (as otherwiſe it would) begin to fall, as having a longer cylinder, than was requiſite to make an æquilibrium with the other fluid. For, by our expedient, the preſſure of the oil was already full as great, if not greater, againſt the lower part of the mercurial cylinder, as that, which the weight of ſo ſhort a cylinder could exerciſe upon the contiguous and ſubjacent oil. And accordingly, upon the removal of my finger, the quickſilver did not run out, but remain ſuſpended in the lower part of the pipe. And as, if I raiſed it towards the ſuperficies of the oil, the mercury would drop out for want of its wonted counterpoiſe; ſo, if I thruſt the pipe deeper into the oil, the increaſed preſſure of the oil would proportionably impel up the mercury towards the higher parts of the pipe; which being again a little, and but a little, raiſed, the quickſilver would fall down a little nearer the bottom of the pipe: and ſo, with a not unpleaſant ſpectacle, the ponderous body of quickſilver was made ſometimes to riſe, and ſometimes to fall; but ſtill to float upon the ſurface of a liquor lighter than common ſpirit of wine itſelf.

BUT, beſides that the experiment, if the maker of it be not very careful, may eaſily enough miſcarry, the divertiſement it gives ſeldom proves laſting; the oil of turpentine, after a while, inſinuating itſelf betwixt the ſides of the pipe and thoſe of ſo ſhort a cylinder of mercury, and thereby diſordering all. And therefore, though I here mention this experiment, as I tried it in oil of turpentine, becauſe that is the liquor I make uſe of all along theſe paradoxes; and becauſe alſo I would ſhew, that a lighter fluid than water (and therefore why not air, if its height be greatly enough increaſed?) may, by its weight and preſſure, either keep the mercury ſuſpended in pipes, or even raiſe it in them: yet I found water, wherewith I filled tall glaſſes, a fitter liquor than oil for the experiment, in which though I ſought, and found ſome other phænomena; yet, becauſe they more properly belong to another place, I ſhall leave them unmentioned in this.

AND ſince experience ſhews us, that a cylinder of mercury, of about thirty inches high, is equiponderant to a cylinder of water of about thirty-three, or thirty-four foot high; it is very eaſy to conclude, that the weight of the external air, which is able to raiſe and keep ſuſpended thirty-three or thirty-four foot of water in a pump, may do the like to twenty-nine or thirty inches of quickſilver in the Torricellian experiment.

## PARADOX V.

*That the preſſure of an external fluid is able to keep an heterogeneous liquor ſuſpended at the ſame height in ſeveral pipes, though thoſe pipes be of very different diameters.*

THE contrary of this propoſition is ſo confidently aſſerted and believed by thoſe mathematicians and others, that favour the doctrine of the ſchools, that this perſuaſion of theirs ſeems to be the chief thing, that has hindered men from acknowledging, that the quickſilver, in the Torricellian experiment, may be kept ſuſpended by the counterpoiſe of the external air. And a famous writer, that has lately treated, as well of the Hydroſtaticks, as of the phænomena of the Torricellian experiment, does rely ſo much upon the falſhood of our paradox, that, laying aſide all other arguments, he contents himſelf to confute his adverſaries with one demonſtration (as he calls it) grounded on the quite contrary of what we here aſſert. For his objection runs to this ſenſe; That, if it were the preſſure of the external air, that kept the quickſilver ſuſpended in the newly-mentioned experiment, the height would not (as experience ſhews it is) be the ſame in all cylindrical pipes, though of very differing bores. For, ſuppoſing the height of the mercurial cylinder, in a tube of half an inch diameter, to be twenty-nine inches; it is plain, that a mercurial cylinder of the ſame height, and three inches in diameter, muſt weigh divers times as much as the former: and therefore the preſſure of the external air being but one and the ſame, if it be a juſt counterpoiſe to the greater cylinder, it cannot be ſo to the leſs: and if it be able to keep the one ſuſpended at twenty-nine inches, it muſt be able to keep the other ſuſpended at a far greater height; which yet is contrary to experience. And indeed this objection is ſo ſpecious, that, though I elſewhere have already anſwered it, both by reaſon and experience, as far forth as its concerns the Torricellian experiment; yet, to ſhew the miſtake, on which it is grounded, it may be very well worth while to make out our propoſed paradox, (as that, whoſe truth will ſufficiently diſprove that error) by ſhewing, both *that* the aſſertion is true, and *why* it muſt be ſo.

Fig. VI. PROVIDE, then, a more than ordinarily wide-mouthed glaſs, clear, and of a convenient depth; into which having put a convenient quantity of water, deeply tinged with brazil, or ſome other pigment, fit to the orifice a broad but thin cork, in which, by burning or cutting, make divers round holes of very differing wideneſſes; into each of which you may thruſt a glaſs cylinder, open at both ends, and of a ſize fit for the hole, that is to receive it, that ſo the ſeveral pipes may be embraced by theſe ſeveral holes; and, as near as you can, make them parallel to one another, and perpendicular to the ſuperficies of the water, into which they are to be immerſed. But we muſt not forget, that, beſides theſe holes, there is an aperture to be made in the ſame cork (it matters not much of what figure, or whereabouts) to receive the ſlender end of a glaſs funnel; by which oil may be conveyed into the veſſel, when it is ſtopped with the cork. And in the ſlender part of this funnel we uſe to put ſome cotton-wick, to break the violence of the oil, that is to be poured in, which might elſe diſorder the experiment. All this being thus provided, and the cork (furniſhed with its pipes) being fitted to the orifice of the veſſel; if at the funnel you pour in oil of turpentine, and place the glaſs betwixt your eye and the light, you may, through that tranſparent liquor, perceive the tincted water to be impelled up into all the pipes, and to riſe uniformly in them. And, when this tincted liquor has attained to the height of two or three, or more inches, above the lowermoſt ſurface of the external oil, if you remove the funnel, (which yet you need not do, unleſs there be yet oil in it) you may plainly perceive the water to reach as high in one of the ſmaller pipes, as in another three or four times as great; and yet the water in the ſeveral pipes, as it is evident, is ſuſtained at that height above the level of the other water, by the preſſure or counterpoiſe of the external oil; which therefore, being lighter *in ſpecie* than water, will have its ſurface ſomewhat higher without the pipes, than that of the tincted water within them. And if by the aperture, that receives the funnel, you immerſe, almoſt to the bottom of the oil, the ſhorter leg of a ſlender glaſs ſiphon, at whoſe longer leg you procure by ſuction the oil to run out; you ſhall perceive, that, according as the depth and preſſure of the external fluid decreaſes, ſo the water in the pipe will ſubſide; and that uniformly, as well in the leſſer, as in the greater pipes.

THE reaſon of this is not difficult to be rendered by the doctrine already delivered. For, ſuppoſe E F to be the ſurface of the water, both within and without the pipes, before any oil was poured on it: if we then ſuppoſe the oil to be poured in through the funnel, its lightneſs in reſpect of water, wherewith it will not mingle, will keep it from getting into the cavity of the pipes L, M, N; and therefore, ſpreading itſelf on the outſide of them above, it muſt neceſſarily, by its gravity, preſs down the ſuperficies of the external water, and impel up that liquor into the cavities of the pipes. And if we ſuppoſe the pouring on of the oil to be continued, till the uppermoſt ſurface of the oil be raiſed to G H, and that of the external water depreſſed to I K, (or thereabouts) an imaginary plane paſſing along the lower orifices of the pipes; I ſay, the tincted waters in the pipes ought to have their uppermoſt ſurfaces in the ſame level, notwithſtanding the great inequality of their bores. For that part of the ſurface I K, which is comprehended within the circular orifice of the greateſt pipe L, is no more charged by the incumbent water, than any other part, equal to that circle of the ſame imaginary ſuperficies, is by the water or oil incumbent on it; (and conſequently, no more than the part, comprehended within the circle of the ſmall pipe N, is by the water contained in that ſmall pipe) the external oil having as much a greater height upon the ſuperficies I K, than the water within the pipe, as is requiſite to make the two liquors counterbalance each other, notwithſtanding the difference of their ſpecifick gravities. And though the pipe L were twice as big, it would charge the ſubjacent plane I K no more, than the preſſure of the oil on the other parts of the ſame imaginary ſurface is able to reſiſt. And yet this preſſure of the external oil ought not to be able to raiſe the water in the ſlender pipe N higher, than the ſurface Q in the ſame level with the ſurface O. For, if the water were higher in the ſmall pipe, being a heavier liquor than oil, it muſt preſs upon that part of the ſurface I K, it leans on, with greater force, than the external oil upon the other parts of the ſame plane I K; and therefore with greater force, than the weight of the external oil could reſiſt. And, conſequently, the water in the ſlender pipe muſt ſubſide, till its ſurface be inferiour to that of the external oil; ſince, till then, the difference of their ſpecifick gravities cannot permit them to reſt in an æquilibrium. To be ſhort; it is all one to the reſiſtance of the external oil, how wide the cylinder is, that it ſupports in the pipe; provided the height of it be not greater, in reſpect of the height of the oil, than the difference of the reſpective gravities of thoſe two liquors requires. For, ſo long the preſſure of the cylinder of water will be no greater on that part of the imaginary ſuperficies, which it leans upon, than the preſſure of the external oil will be on all the other parts of the ſame ſuperficies; and conſequently, neither the one, nor the other of thoſe liquors will ſubſide, but they will both reſt in an æquilibrium.

BUT here it will not be amiſs to note, firſt, that it is not neceſſary, that the glaſs cylinder L, M, N, ſhould be all of the ſame length; ſince the lower orifice being open, the water will riſe to the ſame height within them, whether the parts immerſed under the water be exactly of the ſame length, or no.

AND ſecondly, That throughout all this diſcourſe, and particularly in the explication of this paradox, we ſuppoſe, either that the ſlendereſt pipes, that are employed about theſe experiments, are of a moderate ſize, and not exceeding ſmall; or that, in caſe they be very ſmall, allowance be made in ſuch pipes for this property, that water will riſe in them to a greater height, than can be attributed to the bare counterpoiſe of either the water, or the oil, that impels it upwards, and keeps it ſuſpended. But this difference is of ſo little moment in our preſent inquiries, that we may ſafely neglect it, (as hereafter we mean to do) now we have taken this notice of it for prevention of miſtakes.

## PARADOX VI.

*If a body be placed under water, with its uppermoſt ſurface parallel to the horizon; how much water ſoever there may be on this, or that ſide above the body, the direct preſſure, ſuſtained by the body, (for we now conſider not the lateral, nor the recoiling preſſure, to which the body may be expoſed, if quite environed with water) is no more, than that of a column of water, having the horizontal ſuperficies of the body for its baſis, and the perpendicular depth of the water for its height.*

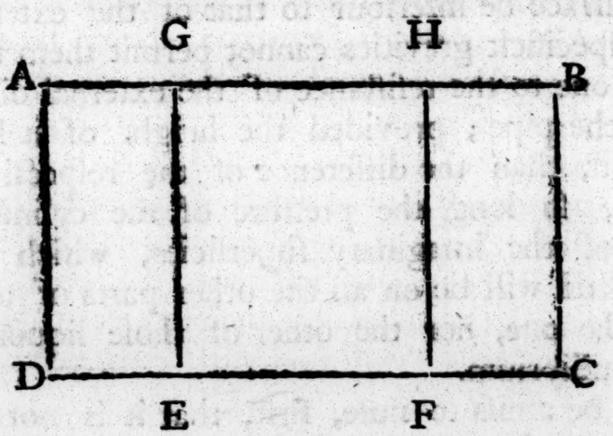
*And ſo likewiſe,*

*If the water, that leans upon the body, be contained in pipes open at both ends, the preſſure of the water is to be eſtimated by the weight of a pillar of water, whoſe baſis is equal to the lower orifice of the pipe, (which we ſuppoſe to be parallel to the horizon) and its height equal to a perpendicular reaching thence to the top of the water; though the pipe be much inclined towards the horizon, or though it be irregularly ſhaped, and much broader in ſome parts, than the ſaid orifice.*

*STEVINUS*, in the tenth propoſition of his Hydroſtatical Elements, having propoſed in more general terms the former part of our paradox, annexes to it a demonſtration to this purpoſe:

HAVING firſt ſuppoſed A B C D to be a ſolid rectangular figure of water, whoſe baſis E F is parallel to the horizon, and whoſe height G E is a perpendicular let fall from the uppermoſt ſurface of the water to the lowermoſt; his demonſtration is this:

Fig. VII.



IF the bottom E F be charged with a greater weight, than that of the water G H F E, that ſurpluſage muſt come from the adjoining water: therefore, if it be poſſible, let it be from the water A G E D, and H B C F; which granted, the bottom D E will likewiſe have a greater weight incumbent on it, upon the ſcore of the neighbouring water G H F E, than that of the water A G E D. And, the reaſon being the ſame in all the three caſes, the baſis F C muſt ſuſtain a greater weight, than that of the water H B C F: and therefore the whole bottom D C will have a greater weight incumbent on it, than that of the whole water A B C D; which yet (A B C D being a rectangular body) would be abſurd. And by the ſame way of reaſoning you may evince, that the bottom E F ſuſtains no leſs a weight, than that of the water G H F E. And ſo, ſince it ſuſtains neither a greater weight, nor a leſs, it muſt ſuſtain juſt as much weight, as the column of water G H F E.

THIS demonſtration of the learned *Stevinus* may well enough be admitted by a naturaliſt, (though, according to ſome hypotheſes touching the cauſe and nature of gravity, it may fail of mathematical exactneſs) and by it may be confirmed the firſt part of our propoſed paradox. And ſome things, annexed by *Stevinus* to this demonſtration, may be alſo applied to countenance the ſecond. But, becauſe this is one of the nobleſt and uſefulleſt ſubjects of the Hydroſtaticks, we think it worth while to illuſtrate, after our manner, each of the two parts of our paradox by a ſenſible experiment.

Fig. VIII.

FIRST then, take a ſlender glaſs pipe, of an even bore, turned up at one end like the annexed ſiphon. Into this ſiphon ſuck oil of turpentine, till the liquor have filled the ſhorter leg, and be raiſed two or three inches in the longer. Then, nimbly ſtopping the upper orifice with your finger, thruſt the lower part of the ſiphon ſo far into a deep glaſs full of water, that the ſurface of the oil in the longer leg of the pipe may be but a little higher than that of the external water; and, upon the removal of your finger, you will find the ſurface of the oil to vary but little, or not at all, its former ſtation. And as, if you then thruſt the pipe a little deeper, you will ſee the oil in the ſhorter leg to begin to be depreſſed; ſo, if afterwards you gently raiſe the pipe toward the top of the water, you ſhall ſee the oil not only regain its former ſtation, but flow out by degrees in drops, that will emerge to the top of the water. Now, ſince the water was able, at firſt, to keep the oil in the longer leg of the pipe ſuſpended no higher, than it would have been kept by a cylinder of water equal to the orifice of the ſhorter leg of the pipe, and reaching directly thence to the top of the water; (as may be eaſily tried, by making a ſiphon, where the ſhorter leg may be long enough to contain ſuch a cylinder of water to counterpoiſe the oil in the longer) and ſince, when once, by the raiſing of the pipe, the height of the incumbent water was leſſened, the oil did more than counterbalance it, (as appears by its flowing out of the ſiphon) we may well conclude, that, though there were in the veſſel a great deal of water, higher than the immerſed orifice of the ſiphon, (and it would be all one, though the ſiphon were placed at the ſame depth in a pond or lake) yet, of all that water, no more did gravitate upon the orifice, than that, which was placed directly over it; which was ſuch a pillar of water, as the paradox deſcribes.

AND, by the way, we may hence learn, that though water be not included in pipes, yet it may preſs as regularly upon a ſubjacent body, as if it were. And therefore we may well enough conceive a pillar of water, in the free water itſelf, where there is nothing on any ſide, but the contiguous water, to bound the imaginary pillar.

BUT I had forgot to add, that the firſt part of our paradox will hold, not only when the water, ſuperior to the body it preſſes upon, is free; but alſo, when it is included in veſſels of never ſo (ſeemingly) diſadvantageous a ſhape. For, if you ſo frame the ſhorter leg of a ſiphon, that it may expand itſelf into a funnel, like that of *fig.* 6. imployed about the proof of the foregoing (fifth) paradox; (for which purpoſe the legs muſt be at a pretty diſtance from each other:) though you fill that funnel with water, the oil in the longer and ſlender leg of the ſiphon will be able to reſiſt the preſſure of all the water, notwithſtanding the breadth of the upper part of the funnel. So that, even in this caſe alſo, the ſurface of the oil in the longer leg will be but a little higher than that of the water in the funnel.

FOR further confirmation of this, we cauſed to be made a ſiphon, ſo ſhaped, that one of the legs (which were parallel, and of the ſame bore) had in the midſt of it a ſphere of glaſs, ſave that it communicated with the upper and lower parts of the ſame leg.

IN the uniform leg of the ſiphon, we put a convenient quantity of oil of turpentine, and into the other as much water, as filled not only the lower part of it, but the globular part too. And yet we did not find, that all this water was able to keep up the oil in the uniform leg, at a greater height, than if the leg, that contained the water, had been uniform too; as much of the water in the globe, as was not directly over the lower orifice of it, being ſupported by the lateral parts (if I may ſo call them) of the ſame globe. And if that leg were, inſtead of water, filled with oil, and the uniform leg with water; notwithſtanding the far greater quantity of oil, that was neceſſary to fill that leg, whereof the hollow ſphere was but a part; the water in the uniform leg would not be kept up, ſo much as to the ſame height with the oil in the miſhapen leg.

Fig. IX. BUT to make this matter yet the more clear, we cauſed a ſiphon to be made of the figure expreſſed in the adjoining ſcheme; into which having poured a convenient quantity of mercury, till it reached in the ſhorter leg C D, almoſt to the bottom of the globulous part E, and in the longer leg A B, to an equal height: we afterwards poured a ſufficient quantity of water into the ſaid longer leg A B, which drove away the quickſilver, and impelled it up in the ſhorter leg till it had half, or more than half, filled the cavity of the globular part E; (which yet we did not wholly fill with quickſilver, becauſe the tube A B was not long enough for that purpoſe:) and then we obſerved, that, notwithſtanding the great weight of (that body, which is of all bodies, ſave one, the moſt ponderous) quickſilver, which was contained in the lower part of the ſame leg of the ſiphon, the ſurface of the quickſilver H G, was impelled up as high by the water in the leg A B, as the diſparity of the ſpecifick weights of thoſe two liquors (whereof one is about fourteen times as heavy as the other) did require: ſo that it appeared not, that, for all the great weight of quickſilver, contained in the globulous cavity E, there preſſed any more upon the ſlender and ſubjacent part E C of that leg, than as much as was placed directly over the lower orifice of the ſaid cavity E. So that the other, and lateral parts of that mercury being ſupported by the concave ſides of the glaſs, whereunto they were contiguous, the water in the leg A B appeared not any more preſſed by the quickſilver, than if the leg C D had been, as well as the other, of an uniform bigneſs; and, by this means, if we had made the hollow globe of a large diameter, a ſmall quantity of water, poured into the leg A B, might have been able to raiſe a quantity of quickſilver exceedingly much heavier than itſelf. But then ſo little water can raiſe the quickſilver, in ſo broad a pipe, but to an inconſiderable height.

To make out the ſecond part of our paradox by an experiment, we took three glaſs-pipes; the one made like a bolt-head, with a round ball, and two oppoſite Fig. X. ſtems; the other was an irregular pipe, blown with an elbow, wherewith it made an angle; and the third was as irregularly ſhaped, as I could get it blown; being in ſome places much broader, and in ſome much narrower than the lower orifice of it. And theſe two laſt named pipes had their upper ends ſo inſerted into holes, made fit for them in a broad piece of cork; that, when they were immerſed, they made not right angles, but very oblique ones, with the horizontal ſurface of the liquor. The other glaſs likewiſe, which conſiſted of a great bubble, and two oppoſite pipes, was faſtned to the ſame cork, which having beforehand been made fit for a wide-mouthed glaſs of a good depth, and half filled with water, was thruſt as a ſtopple into the mouth of the ſaid glaſs, ſo that the water aſcended a pretty way into each of the three pipes by their lower orifices, which, as well as the upper, we left open; then a good quantity of oil of turpentine being poured into the ſame veſſel through a funnel, the water was by the incumbent oil impelled up to the height of two or three inches in each of the three pipes. Which argues, that, notwithſtanding their being ſo unequal in bigneſs, and ſo irregular in ſhape, (inſomuch that we gueſſed one of them was ten or

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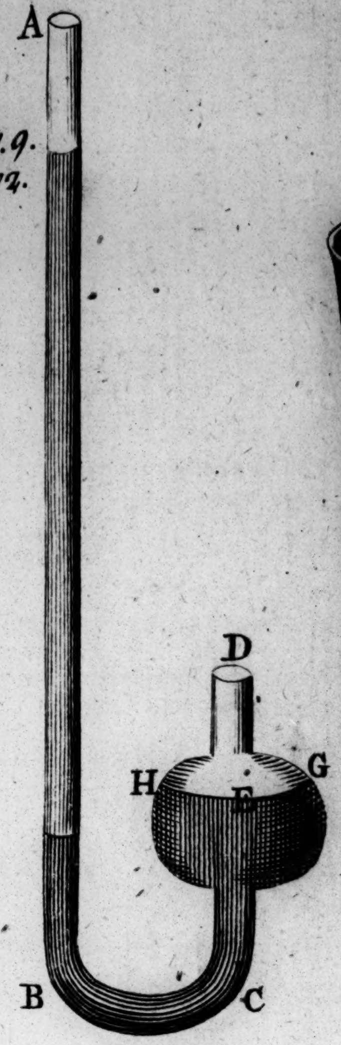

Fig. 9. p. 772.

Fig. 10. p. 772.

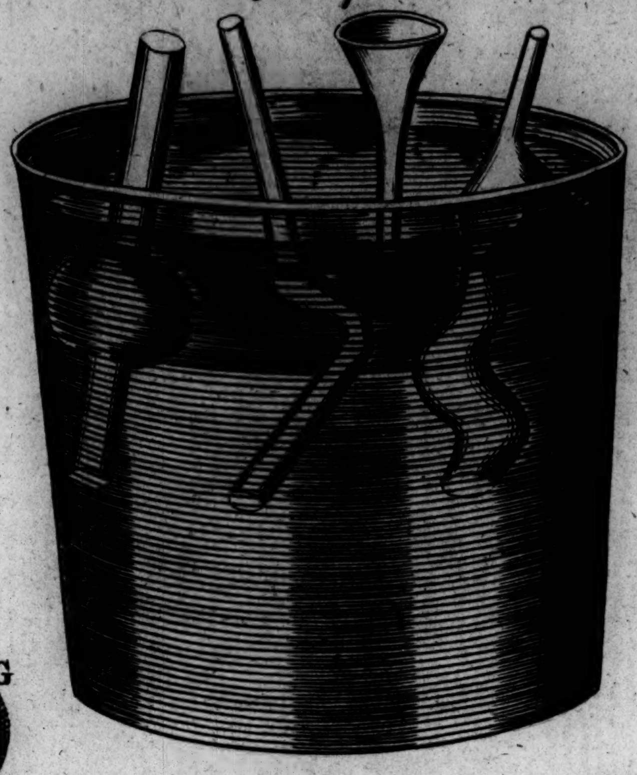

Fig. 11. p. 773.

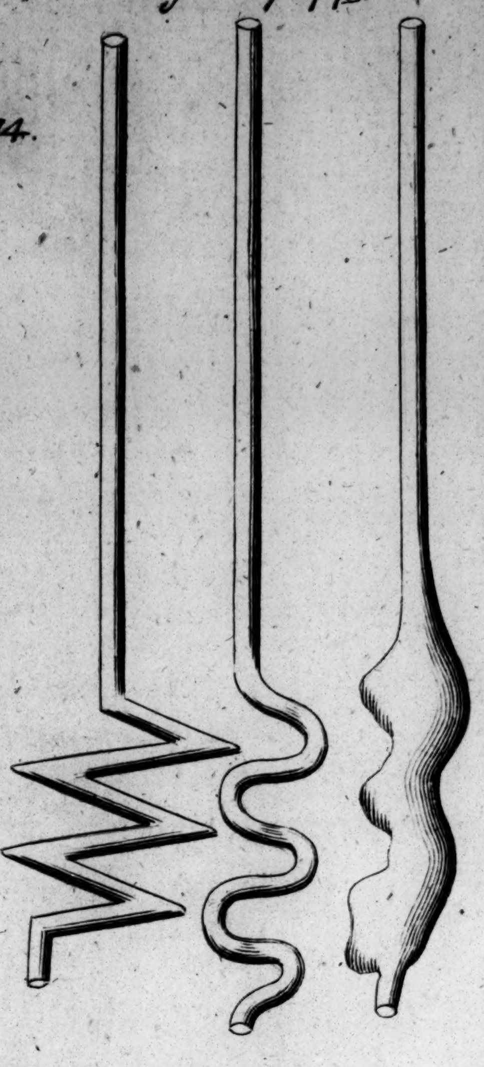

Fig. 12 p. 774.

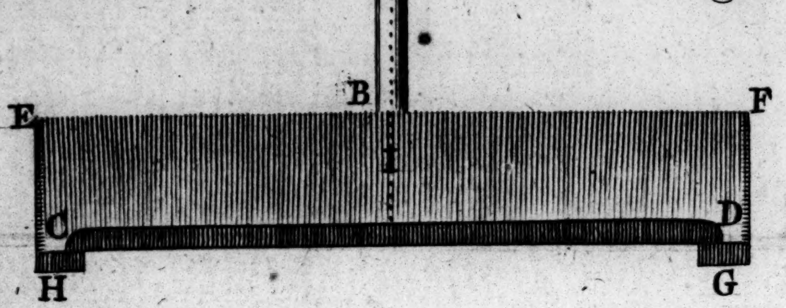
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Fig. 13. p. 775.

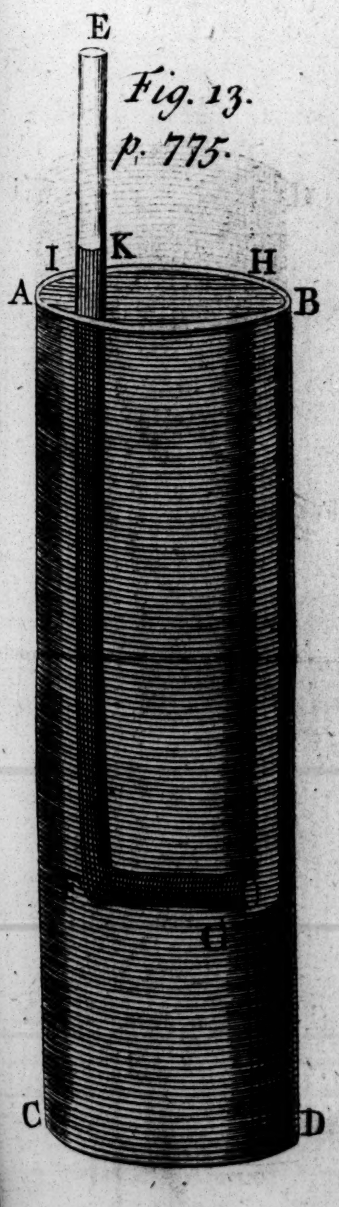

Fig. 14. p. 777.

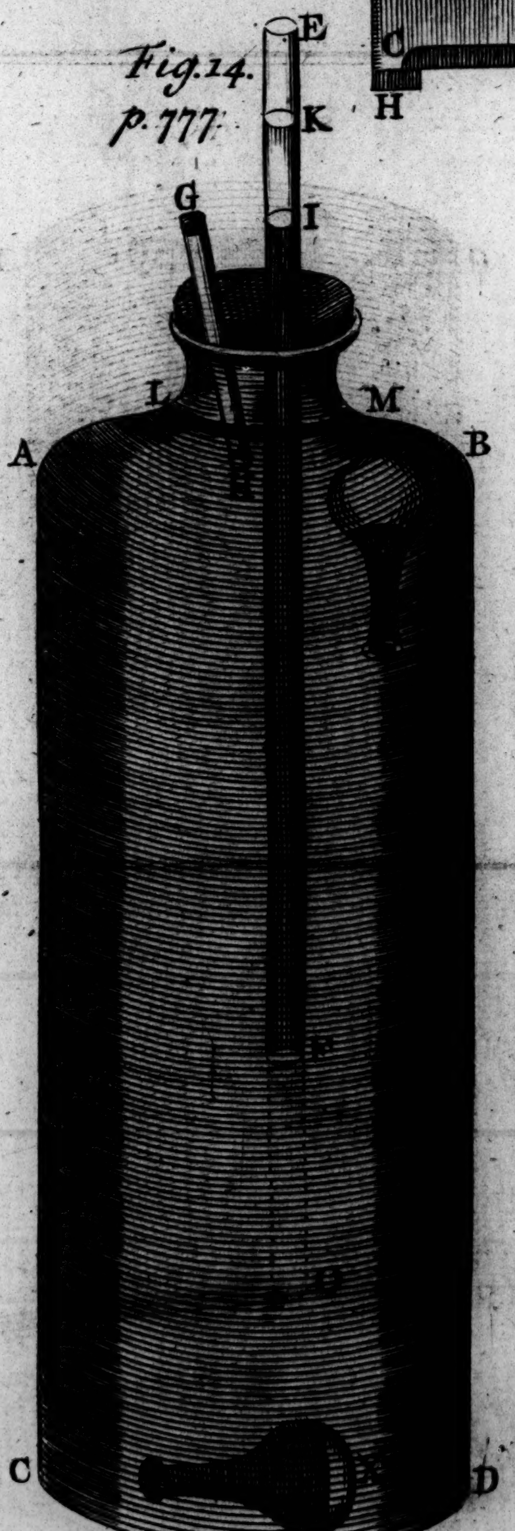
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Fig. 15. p. 779.

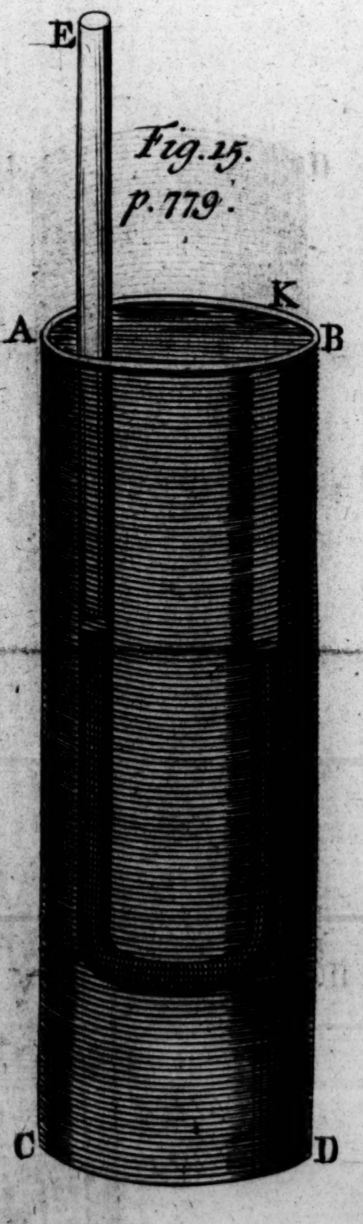
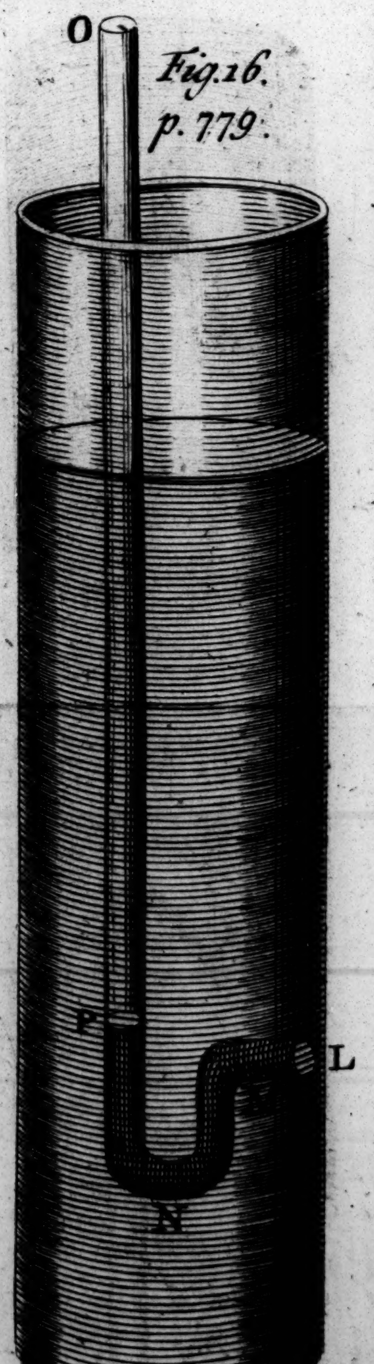


Fig. 16. p. 779.



J. Mynde sc.

or twelve times greater in one part, than in another, or than it was even at the orifice) the water, contained in each of them, preſſed upon its lower orifice no more (I do not add, nor no leſs) than it would have done, if it had been a cylinder, having the orifice for its baſis, and the perpendicular depth of the water and oil above, for its height. For in caſe each of the pipes had contained but ſuch a cylinder of water, that water would nevertheleſs have had its uppermoſt ſuperficies at the ſame height: and, on the other ſide, it would have been impelled up beyond it, if its weight did not as ſtrongly endeavour to depreſs the immediately ſubjacent water, as the preſſure of the external fluids endeavoured to impel it up.

AND ſince the height of the water was about the ſame in the ſeveral pipes, though two of them, being very much inclined, contained much more water than if they were erected; yet by the ſame way of reaſoning we may gather, that the imaginary plain, paſſing by the immerſed orifice of either of theſe inclining pipes, ſuſtained no more of preſſure, than it would have done from a ſhorter cylinder of water, if erected. And indeed, in all theſe caſes, where a pipe either is broader in other places than at its lower orifice, or inclined any way towards the horizon, the weight of the contained liquor is not all ſupported by the liquor, or the body contiguous to the lower orifice, but partly by the ſides of the pipe itſelf. And therefore if, when in a ſlender pipe you have brought a parcel of oil of turpentine to be in an æquilibrium with the external water, as in the experiment belonging to the firſt paradox; if, I ſay, when this is done, you incline the pipe towards the ſides of the glaſs, you may indeed obſerve the ſurface of the oil in the pipe to be, as before, a little higher than that of the water without it: but you ſhall likewiſe ſee, that though the orifice of the pipe were not thruſt deeper into the water, yet there will be a pretty deal of water got up into the pipe; becauſe the oil not leaning now upon the water only, as it did before, but partly upon the water, and partly upon the pipe, its preſſure upon the ſubjacent water is conſiderably leſſened; and thereby the external water, whoſe preſſure is not diminiſhed too, is able to impel up the oil, and intrude for a little way into the pipe. But if you re-erect the pipe, the preſſure of the oil being then again exerted upon the ſubjacent water, it will be able to depreſs, and drive it again out of the cavity of the pipe.

AND to this agrees very well what we further tried as follows: We cauſed three pipes to be blown (ſhaped as the adjoining figures;) one having in it divers acute angles; the other being of a winding form, like a ſkrew or worm of the limbeck; and the third very irregularly crooked; and yet each of theſe pipes having all its crooked parts, and ſome of its ſtreight and erected parts, filled with oil of turpentine; being thruſt to a convenient depth under water and unſtopped there, (after the manner already often declared) we found, that, according to our paradox, the ſurface of the oil in the pipe was higher than that of the water without it, as much as it would have been in caſe the pipe had been ſtreight, (as we tried, by placing by the crookedeſt of them a ſtreight pipe with oil in it) though the quantity of the oil, in one of theſe pipes, were perhaps three times as much as would have ſufficed, if the pipe had been ſtrait: ſo that this ſurpluſage of oil did not preſs upon the ſubjacent water, (for if it had done ſo, the oil would have run out of the pipe.) And I remember, that lifting up as much of one of theſe crooked pipes, as I thought fit, ſomewhat above the ſurface of the water; when the ſuperficies of the oil in the pipe was not above half an inch higher than that of the water without it, I eſtimated, that the crooked pillar of oil, contained in that part of the pipe, which was above the ſurface of the water, was about ſeven or eight inches long. So true it is, that the preſſure of liquors, contained in pipes, muſt be computed by the perpendicular that meaſures their height, whatever be their length or bigneſs.

Fig. XI.

## SCHOLIUM.

THE learned *Stevinus*, having demonſtrated the propoſition we lately mentioned out of him, ſubjoins divers conſectaries, of which the truth hath been thought more queſtionable, than that of the theorem itſelf. And therefore he thought fit to add a kind of appendix to make good a paradox, which ſeems to amount to this; that if, in the cover of a large cylindrical box, exactly cloſed, there be perpendicularly erected a cylindrical pipe open at both ends, and reaching to the cavity of the box; this inſtrument being filled with water, the circular baſis of it will ſuſtain a preſſure, equal to that of the breadth of the baſis and height of the pipe.

I CHOSE thus to expreſs this theorem, (which might be, according to *Stevinus*, propoſed in more general terms) becauſe this way of expreſſing it will beſt ſuit with the ſubſequent experiment, and may conſequently facilitate the underſtanding of the paradox. But though the learned *Stevinus*'s aims were to be commended; who finding this propoſition doubted, ſeems to have had a great mind to give an experimental demonſtration of it, and therefore propoſes no leſs than five pragmatical examples (as he calls them) to make out the truth of what he aſſerts; yet in this he hath been ſomewhat unhappy, that that experiment, which alone (for ought I can find) has been tried of all the five, is rejected as incompetent by thoſe, that profeſs to have purpoſely made trial of it. And indeed, by reaſon of the difficulty of bringing them to a practical examen, I have ſomewhat doubted, whether or no this uſeful writer did ever make all thoſe trials himſelf; rather than ſet down the events, he ſuppoſed they muſt needs have, as preſuming his conjectures rightly deduced from a demonſtrative truth. Wherefore though another of the experiments, he propoſes, be not free from difficulty, yet having, by the help of an expedient, made it practicable, we are induced by its plainneſs and clearneſs to prefer it to what elſe he propoſes to the ſame purpoſe.

See Fig. XII.

WE provided then a veſſel of latten, of the figure expreſſed in the ſcheme, and furniſhed it with a looſe bottom C D, made of a flat piece of wood covered with a ſoft bladder, and greaſed on the lower ſide near the edges, that leaning on the rim of wood G H, contiguous every where to the inſide of the latten, it might be eaſily lifted from off this rim; and yet lie ſo cloſe upon it, that the water ſhould not be able to get out between them: and to the midſt of this looſe bottom was faſtned a long ſtring, of a good ſtrength, for the uſe hereafter to be declared. The inſtrument thus fitted, the water was poured in apace at the top A B, which, by its weight preſſing the falſe bottom C D againſt the ſubjacent rim G H, contributed to make the veſſel the more tight, and to hinder its own paſſing. The veſſel being filled with water, we took the forementioned ſtring, one of whoſe ends was faſtned to I, the middle part of the looſe bottom, and, tying the other end K to the extremity of the beam of a good pair of ſcales, we put weights one after another into the oppoſite ſcale, till at length thoſe weights lifted up the falſe bottom C D from the rim G H; and conſequently lifted up the incumbent water; which preſently after ran down between them. And having formerly, before we poured in any water, tried what water would ſuffice to raiſe the bottom C D, when there was nothing but its own proper weight, that was to be ſurmounted; we found, by deducting that weight from the weight in the ſcale, and comparing the reſidue with the weight of as much water as the cavity of the broad, but very ſhallow cylinder, B E C H G D F, would have alone (if there had been no water in the pipe A I) amounted to; we found, I ſay, by comparing theſe particulars, that the preſſure upon C D was by ſo very great odds more, than could have been attributed to the weight of ſo little water, as the inſtrument,

ment, pipe and all contained, in caſe the water had been in an uniform cylinder, and conſequently a very ſhallow one, of a baſis as large as that of our inſtrument; that we could not but look upon the ſucceſs, as that, which, though it did not anſwer what the reading of *Stevinus* might make a man expect; yet may deſerve to be further proſecuted, that whether or no the paradox of *Stevinus* (which not only ſome others, but the learned Dr. *Wallis* himſelf queſtion) will hold, the inquiry he has ſtarted, may be ſo perſued, as to occaſion ſome improvement of this part of Hydroſtaticks: where, to define things with certainty, will perhaps be found a difficulter taſk than at firſt glance one would think; both becauſe divers ſpeculative things muſt be taken into conſideration, whoſe theory has not perhaps yet been cleared, and becauſe of the difficulty, that will be found in practice by them, that ſhall go about to make *Stevinus*'s experiments, or others of that ſort, with all requiſite accurateneſs. As indeed, it is far eaſier to propoſe experiments, which would in likelihood prove what we intend, in caſe they could be made, than to propoſe practicable expedients, how they may be made.

## PARADOX VII.

*That a body immerſed in a fluid ſuſtains a lateral preſſure from the fluid; and that increaſed, as the depth of the immerſed body, beneath the ſurface of the fluid, increaſeth.*

THOUGH I ſhall not wonder, if this propoſition ſeems ſtrange enough to moſt readers; yet I think I could make it out by ſeveral ways, and particularly by one, that is plain and eaſy, being but that which follows:

TAKE then a ſlender glaſs-pipe (like that imployed about the firſt experiment) and cauſe it to be bent within two or three inches of one end, ſo that the longer and the ſhorter legs, E F and F G, may make, as near as can be, a right angle at F; then dipping the orifice of the ſhorter leg F G in oil of turpentine, ſuck into the ſiphon (if I may ſo call it) as much of the liquor as will fill the ſhorter leg, and reach two or three inches high in the longer: then nimbly ſtopping the upper orifice with your finger, immerſe the lower part of the glaſs under water, in ſuch manner, as that the longer leg E F may make, as to ſenſe, right angles with (A B) the horizontal ſurface of the water; and the ſhorter leg F G may be ſo far depreſſed under that ſurface, that I K, the ſuperficies of the oil in the longer leg, be but a little higher than A B, that of the external water. Then, removing your finger, you may obſerve, that the oil in the ſiphon will continue (with little or no change) in its former ſtation. By which it appears, that there is a lateral preſſure of the water againſt the oil contiguous to G, the orifice of the ſhorter leg of the pipe; ſince it is only that preſſure, that hinders the efflux of the oil at that orifice, notwithſtanding the preſſure of the perpendicular cylinder of oil, that would drive it out. Fig. XIII.

AND that this preſſure of the perpendicular cylinder doth really urge the oil in the ſhorter leg to flow out, you may learn, by ſlowly lifting the ſiphon (without changing its former poſture) towards the ſurface of the water. For as the lower leg comes nearer and nearer to that ſurface, (to which, as I newly intimated, it is ſtill to be kept parallel) the oil in the horizontal leg will be driven out in drops, by the preſſure of the other oil in the perpendicular leg.

THAT likewiſe, before you begin to raiſe the ſiphon, the lateral preſſure of the water againſt the lower orifice of it is, at leaſt in ſuch experiments, near about the ſame with what would be the perpendicular preſſure of a cylinder of water, reaching from the ſame orifice G (or ſome part of it) to the top of the water, may be gathered from hence, that the ſurface of the oil in the longer leg will be a little higher than that of the external water, as (by reaſon of the often mentioned comparative levity of the oil) it would be, if we ſuppoſe, that a pipe of glaſs of the ſame bore, and reaching to the top of the water, being fitted to the orifice of the horizontal leg (as in the annexed figure the cylinder, G H) were filled with water.

AND, to make out the latter part of our propoſition, we need add no more, than that, if you plunge the ſiphon deeper into the water, you ſhall find the oil, by the lateral preſſure of the water, driven by degrees quite out of the ſhorter leg into the longer: and if you thruſt it yet deeper, you may obſerve, that the longer leg will admit a cylinder of water, upon which that of oil will ſwim; the whole oil alone being unable to counterbalance the lateral preſſure of the water at ſo great a depth.

BY which laſt circumſtance, it appears, that water has alſo a lateral preſſure againſt water itſelf, and that increaſed according to its depth; ſince otherwiſe the external water could not impel that in the horizontal leg of the ſiphon into the perpendicular leg, though, to do ſo, it muſt ſurmount the weight or reſiſtance of the whole cylinder of oil, that muſt be here violently raiſed in the ſaid perpendicular leg.

BUT if you gently raiſe the ſiphon again, the lateral preſſure of the water againſt the immerſed orifice being diminiſhed, (according as the diſtance of that orifice G from the horizontal ſurface, A B, comes to be leſſened) the prevalent oil will drive out the water, firſt out of the longer leg, and then out of the ſhorter, and will at length flow out in drops at the immerſed orifice, and thence emerge to the top of the water.

BESIDES, when the oil in the ſiphon does juſt counterbalance the external water, if you keep the ſhorter leg parallel to the ſurface of the water, and move the orifice of it this way or that way, and place it nearer or further off from the middle or from the ſides of the glaſs, (provided you keep it always at the ſame depth under the water) you will find the oil in the longer leg to continue (as to ſenſe) at the ſame height. Whence we may learn (what I have not yet found mentioned by any writer) that, even in the midſt of the water, we may ſuppoſe a pillar of water, of a baſis equal to the ſide of an immerſed body, (and reaching to the loweſt part of it) and that, though this imaginary aqueous pillar, ſuch as in our figure G H, be not included in any ſolid body, or ſtable ſuperficies; nevertheleſs its lower parts will have a lateral preſſure tending outwards, againſt the imaginary ſides, from the weight of the water, that is above theſe ſubjacent and lateral parts; and will have that preſſure increaſed proportionably to the height to which the imaginary pillar reaches above them. Which obſervation, being duly noted and applied, may be of no mean uſe in the explication of divers hydroſtatical phænomena.

AND laſtly, if, inſtead of holding E F, the longer leg of our ſiphon, perpendicular, (and conſequently the ſhorter parallel to the horizon) you variouſly incline the former, ſo as to bring it to make an obtuſe or an acute angle with the ſuperficies of the water A B; though by this means the ſhorter and immerſed leg, F G, will in ſituation ſometimes reſpect the bottom, and ſometimes the top of the glaſs; yet in all theſe oblique ſituations of this leg, and the immerſed orifice of it, G, the oblique preſſure of the water will ſo much depend upon the height of the ſurface of the liquor above the orifice, and ſo much conform to the obſervations already delivered, that you ſhall ſtill ſee the ſurface of the oil I K, in the longer pipe, to be a little, and but a little ſuperiour to that of the external water, A B, and ſo the æquilibrium betwixt the liquor, or liquors, within the ſiphon, and the water without it, will even in this caſe alſo be maintained.

## SCHOLIUM.

REMEMBRING on this occaſion an experiment, which, though it do not ſhew what the preciſe quantity of lateral preſſure is, that the lower parts of the fluid may ſuſtain from the more elevated; yet it may confirm the foregoing paradox, and by its phænomena afford ſome hints, that may render it not unacceptable; I ſhall ſubjoin it, as I ſet it down not long after I deviſed it.

IN the firſt place then, there was made a glaſs bubble with a ſlender neck; and (in a word) of the figure expreſſed in the annexed ſcheme: this bubble I cauſed to be ſo poiſed, that, though it would float upon the water, yet the addition of a weight ſmall enough would ſuffice to make it ſink. Fig. XIV.

THIS done, I provided a very large wide-mouthed glaſs, and cauſed to be fitted to it, as exactly as I could, a ſtopple of cork, which being ſtrongly thruſt in, would not eaſily be lifted up. In the middle of this cork there was burned, with a heated inſtrument, a round hole; through which was thruſt a long ſlender pipe of glaſs; ſo that the lower end of it was a pretty way beneath the cork, and the upper part of it was, as near as could be, at right angles with the upper part of the ſaid cork. And in another part of the ſtopple, near the edge, there was made another round hole, into which was likewiſe thruſt another ſmall pipe; whoſe lower part reached alſo a pretty way beneath the cork, but its upper part was but about two or three inches high; and the orifice of this upper part was carefully cloſed with a ſtopple and cement. Then the glaſs-veſſel being filled with water, and the poiſed bubble being made to float upon it, the ſtopple or cover of the great glaſs-veſſel was put on, and made faſt with a cloſe cement, that nothing might get in or out of the veſſel, but at the long ſlender pipe: which was faſtned into the cork (as was alſo the ſhorter pipe) not only by its own fitneſs to the hole it paſſed through, but by a ſufficient quantity of the ſame cement, carefully applied to ſtop all crevices.

THE inſtrument thus prepared, (and inclined this or that way, till the floating bubble was at a good diſtance from that end of the long pipe, which reached a pretty way downwards beneath the ſurface of the water) we began to pour in ſome of that liquor at the open orifice of the pipe E F; and, the mouth of the veſſel being exactly ſtopped, the water, for want of another place to receive it, aſcended into the pipe, through which it had fallen before. And, if I held my hand, when the water I had poured in was able to reach but to a ſmall height in the cylinder, as for inſtance, to the ſuperficies J; the bubble X would yet continue floating. But, if I continued pouring, till the water in the pipe had attained a conſiderable height above the ſurface of that in the veſſel, as if it reached to K; then the bubble X would preſently ſink to the bottom of the veſſel, and there continue, as long as the water continued at ſo great a height in the pipe E F.

THIS experiment will not only teach us, that the upper parts of the water gravitate upon thoſe, that are under them, but (which is the thing we are now to confirm) that in a veſſel, that is full, all the lower parts are preſſed by the upper, though theſe lower be not directly beneath the upper, but aſide of them, and perhaps at a good diſtance from the line, in which they directly preſs; theſe things, I ſay, may be made out by our experiment. For the addition of the cylinder of water K J, in the pipe E F, makes the bubble X ſubſide; as the force or preſſure of any other heavy body upon the water in the veſſel would do. And ſince (as may be gathered from the reaſon formerly given, in the proof of the ſecond paradox, of the ſinking of poiſed bubbles) the included air in our bubble was notably compreſſed; it will follow, that the cylinder of water K I did preſs the ſubjacent water in the veſſel: for, without ſo doing, it could not be able to compreſs the air in the bubble. And ſince the ſaid bubble did not ſwim directly under, or near the pipe E F, but at one ſide of it, and at a pretty diſtance from it, nay, and floated above the lower orifice F of the pipe; it is evident, that that aqueous cylinder I K does not only preſs upon the water, or other bodies, that are directly under it; but upon thoſe alſo, that are laterally ſituated in reſpect of it, provided they be inferiour to it.

AND, according to this doctrine, we may conceive, that every aſſignable part of the ſides of the veſſel does ſuſtain a preſſure, increaſed by the increaſe of that part's depth under water, and according to the largeneſs of the ſaid part. And therefore, if any part were ſo weak, as that it would be eaſily beaten out, or broken by a weight equal to the cylinder I K, (making always a due abatement for the obliquity of the preſſure) it would not be fit to be a part of our veſſel: nay, the cork itſelf, though it be above the ſurface of the water in the veſſel; yet, becauſe the water in the pipe is higher than it, each of its parts reſiſts a conſiderable preſſure, proportionate to its particular bigneſs, and to the height of the water in the pipe. And therefore, if the cork be not well ſtopped in, it may be lifted up by the preſſure of the water in the pipe, if that be filled to a good height. And if the cement be not good and cloſe, the water will (not without noiſe) make itſelf a paſſage through it. And if the ſtopple G, of the ſhorter pipe G H, (which is placed there likewiſe to illuſtrate the preſent conjecture) do not firmly cloſe the orifice of it, it may be forced out, not without violence and noiſe. And, for further ſatisfaction, if, inſtead of the ſtopple G, you cloſe the orifice with your finger, you ſhall find it preſſed upwards as ſtrongly, as it would be preſſed downwards by the weight of a cylinder of water of the breadth of the pipe, and of a not inconſiderable height, (for it is not eaſy to determine preciſely, what height) ſo that (to be ſhort) in the fluid body we made our trial with, the preſſure of the ſuperiour parts was communicated, not only to thoſe, that were placed directly under them, but even to thoſe, that were but obliquely ſo, and at a diſtance from them.

I HAD forgot to confirm, that it was the preſſure of the ſuperiour parts of the water, that made our floating bubble ſink, by ſuch another circumſtance, as I took notice of in ſome of the former experiments; *viz.* that, when it lay quietly at the bottom of the veſſel, if, by inclining the inſtrument, we poured off as much of the water in the pipe E F, as ſufficed competently to diminiſh its height above the water in the veſſel A B C D, the air in the bubble, finding its former preſſure alleviated, would preſently expand itſelf, and make the bubble emerge. And to ſhow, that the very oblique preſſure, which the bubble ſuſtained from the water in the pipe, was not over-much differing from that, which it would have ſuſtained from an external force, or from the weight of water placed directly over it; I cauſed two ſuch bubbles to be poiſed, and having put each of them into a long cylindrical glaſs, open above, and filled with water, upon which it floated, if we thruſt it down a little way, it would (agreeably to what hath been above related) aſcend again: ſo that we were forced to thruſt it down to a good depth, before the preſſure of the incumbent water was great enough to make it ſubſide.

See the proof of the ſecond paradox.

AND, perhaps, it will not be impertinent to take notice, before we conclude, how the preſſure of ſuch differing fliuds, as air and water, may be communicated to one another. For having ſometimes forborn to fill the veſſel A B C D quite full of water, ſo that, when the cork was fitted to it, there remained in it a pretty quantity of air, (as between the ſurface L M, and the cork) nevertheleſs, if the ſtopple or cork were very cloſely put in, the preſſure of the water, that was afterwards poured into the pipe E F, from J to K, would make the bubble ſink little otherwiſe, for aught I took notice of, than if the veſſel had been perfectly filled with water; the air, (above L M) that was both impriſoned and compreſſed, communicating the preſſure it received to the water contiguous to it.

## PARADOX VIII.

*That water may be made as well to depreſs a body lighter than itſelf, as to buoy it up.*

HOW ſtrange ſoever this may ſeem to thoſe, that are prepoſſeſſed with the vulgar notions about gravity and levity; it need not be marvelled at by thoſe, that have conſidered, what has been already delivered. For ſince, in fluid bodies, the upper parts preſs upon the lower, and upon other bodies, that lie beneath them: and ſince, when a body is unequally preſſed by others, whether lighter, or heavier than itſelf, it muſt neceſſarily be thruſt out of that place, where it is more preſſed, to that, where it is leſs preſſed; if that a parcel of oil be, by a contrivance, ſo expoſed to the water, as that the water preſſes againſt its upper ſuperficies, and not againſt the undermoſt, or lateral parts of it; if we ſuppoſe, that there is nothing (whoſe preſſure is not inferiour to that of the water) to hinder its deſcent, (ſuppoſing, withal, that the oil and water cannot paſs by one another; for which cauſe we make uſe of a ſlender pipe) the oil muſt neceſſarily give way downwards, and conſequently be depreſſed, and not buoyed up. This is eaſily exemplified by the following experiment.

TAKE a ſlender glaſs ſiphon E F G H, of the bore we have often mentioned, whoſe ſhorter leg G H may be about three or four inches long, and as parallel, as the artificer can make it, to the longer E F; dip the ſhorter leg in oil of turpentine, till the oil quite fill the ſhorter leg, and reach to an equal height in the longer, as from F to J. Then, ſtopping the orifice E of the longer leg with your finger, and immerſing the repleniſhed part of the ſiphon about an inch under water, you ſhall perceive, that, as you thruſt it lower and lower, upon the removal of your finger, the oil in the ſhorter leg will be made to ſink about an inch, or ſomewhat more; and as, afterwards, you thruſt the pipe deeper, the oil in the ſhorter leg will, by the weight of the incumbent water H K, be driven downward more and more, till it come to the very bottom of the ſhorter leg; whence, by continuing the immerſion, you may impel it into the longer. The cauſe of which phænomenon I ſuppoſe to be already clearly enough aſſigned, to make it needleſs to add any thing here about it. Fig. XV.

IT remains, that, before I proceed to the next propoſition, I add; that, to exemplify at once three paradoxes, (both this, and the next foregoing, and the ſecond) I cauſed to be made a ſlender glaſs-pipe, of the figure expreſſed in the annexed ſcheme, and having, by the lower orifice L, ſucked into it as much oil of turpentine, as reached, in the longeſt leg N O, as high as the top of the other part of the glaſs; (namely, to the part P, in the ſame level with the orifice L) I firſt ſtopped the upper orifice of it, O, with my finger. And then, thruſting it as before under water to a convenient depth, upon the removal of my finger, the external water did firſt drive away the oil, that was in L M, that part of the crooked pipe which was parallel to the horizon; then it depreſſed the ſame oil to the bottom of the ſhorter leg, that is, from M to N: and laſtly, it impelled it all up into the longer leg N P O, to what height I thought fit. So that the oil was preſſed by the water, both laterally, down- Fig. XVI.

wards, and upwards: the cauſes of which are eaſily deducible from the doctrine already delivered.

## PARADOX IX.

*That, whatever is ſaid of poſitive levity, a parcel of oil lighter than water, may be kept in water without aſcending in it.*

TO make out what I have to repreſent about this paradox the more intelligible, the beſt way perhaps will be to ſet down the conſiderations, that induced me to judge the thing it pretends to feaſible. And in order to this, it would be expedient to conſider, why it is, that a body lighter *in ſpecie* than water, being placed never ſo much beneath the ſuperficies of that liquor, will rather emerge to the top, than ſink to the bottom of it; if we had not already conſidered that problem in the explication of the third paradox. But being now allowed to apply to our preſent purpoſe what hath been there delivered, I ſhall forthwith ſubjoin, that it was eaſy enough for me to collect from hence, that the reaſon, why it ſeems not poſſible, that a parcel of oil lighter than water ſhould without violence be kept from emerging to the top of it, being this, *That ſince the ſurface of a veſſel full of ſtanding water is (phyſically ſpeaking) horizontal, the water, that preſſes againſt the lower part of the immerſed body, muſt needs be deeper than that, which preſſes againſt the upper:* If I could ſo order the matter, that the water, that leans upon the upper part of the body ſhould, by being higher than the level of the reſt of the water, have a height great enough to balance that, which preſſes againſt the lower, (and the bodies not ſhift places, by paſſing one by the other) the oil might be kept ſuſpended betwixt two parcels of water.

To reduce this to practice, I took the following courſe; having ſucked into a ſlender pipe (ſuch as that imployed about the firſt experiment) about an inch of water, and kept it ſuſpended there, by ſtopping the orifice of the pipe; I thruſt the lower part of the pipe about two inches beneath the ſurface of ſome oil of turpentine (which, to make the effect the clearer, I ſometimes tinge deeply with copper) then removing my finger, the oil being preſſed againſt the immerſed orifice with a greater force, than the weight of ſo little ſuſpended water could reſiſt, that oil was impelled into the lower part of the pipe to the height of near an inch; and then again I ſtopped the upper oriifice of the pipe with my finger, and thereby keeping both the liquors ſuſpended in it, I thruſt the pipe into a glaſs full of water, three or four inches beneath the ſurface of it; and then (for the reaſon juſt now given) the water, upon the removal of my finger, will preſs in at the lower orifice of the pipe, and impel up the oil, till they come to ſuch a ſtation, as that expreſſed in the annexed ſcheme: where P Q is the water, newly impelled up into the pipe, Q R is the oil, and R S the water, that was at firſt ſucked into the pipe. For in this ſtation theſe three liquors do altogether as much gravitate upon the part P, as the incumbent water alone does upon the other parts of the imaginary ſuperficies G H; and yet the oil, R Q, does not aſcend, becauſe the diffluence of the water, R S, being hindered by the ſides of the pipe, its ſuperficies, T S, is higher than A D, the ſuperficies of the reſt of the water; by which means the incumbent water may be brought to have upon the upper part R of the oleous cylinder, as great a preſſure as that of the water, that endeavours to impel upwards the lower part Q of the ſame ſuſpended cylinder of oil.

Fig. XVII.

Fig. 17. p. 780.

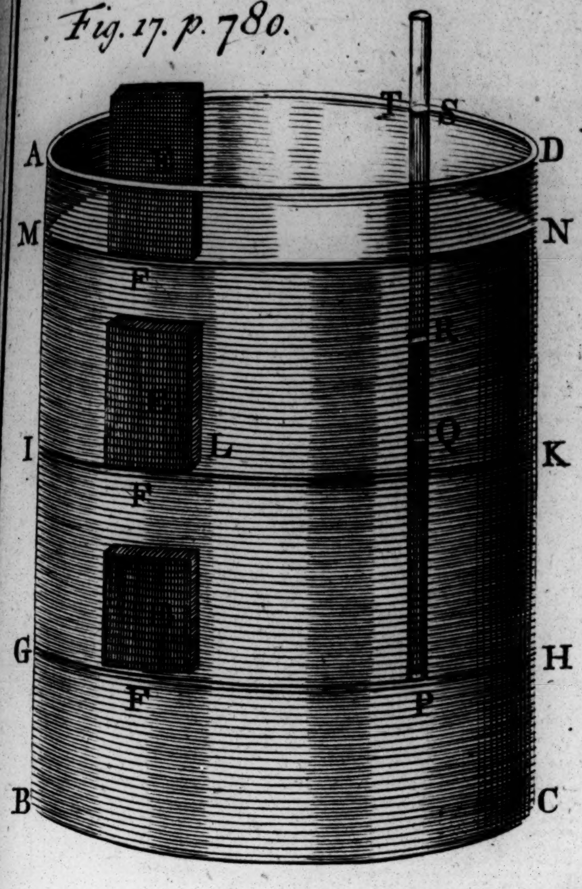

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Fig. 18. p. 781.

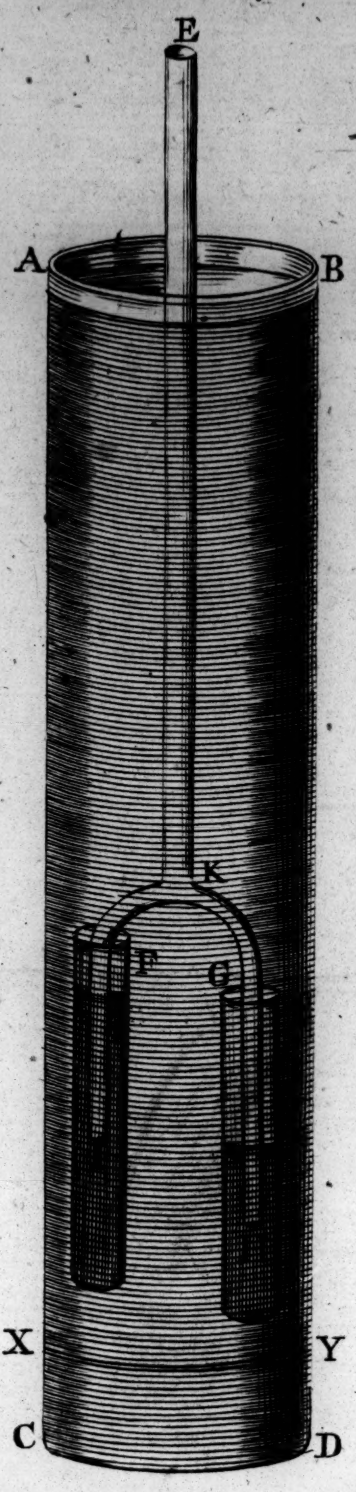
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Fig. 19. p. 784.

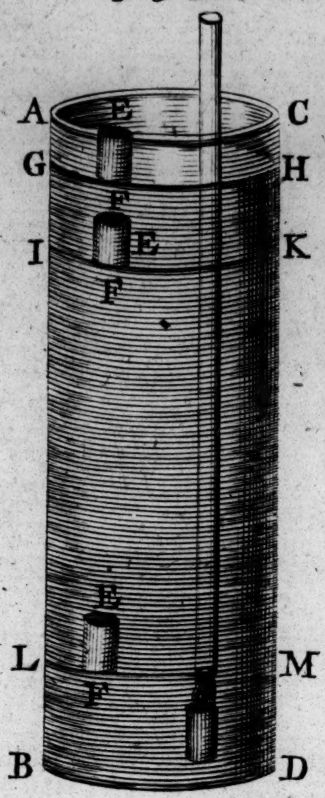
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Fig. 20. p. 785.

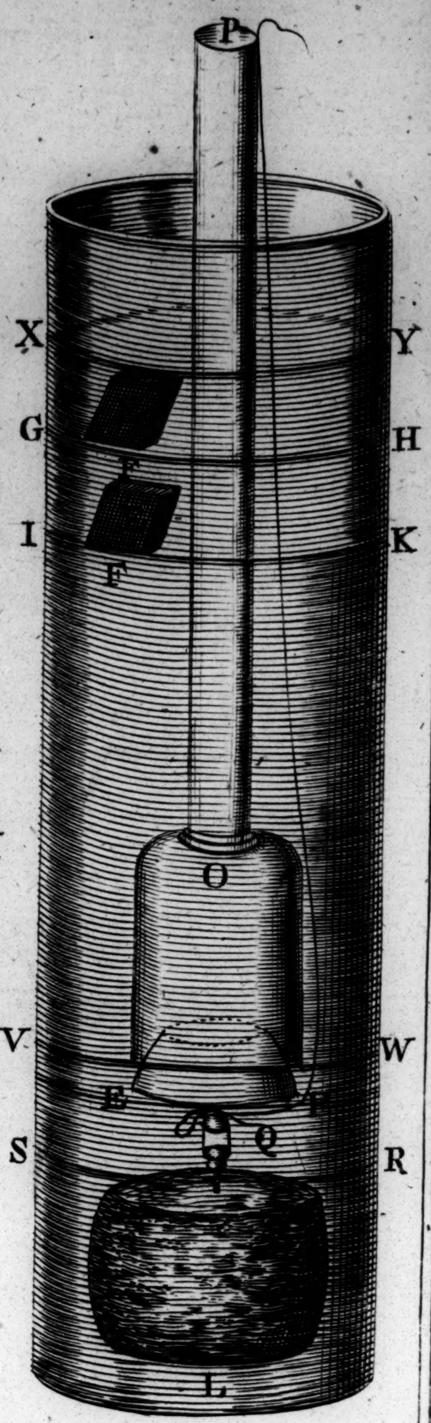
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Fig. 21. p. 788.

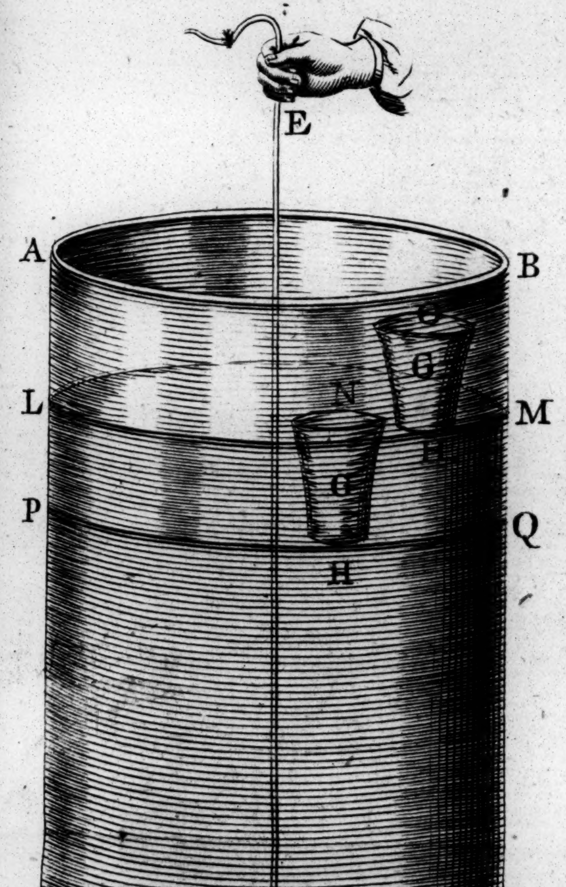
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Fig. 22. p. 793.

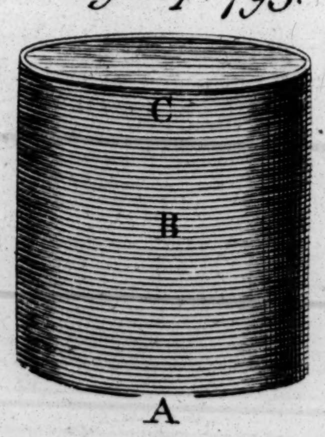


Fig. 23. p. 795.

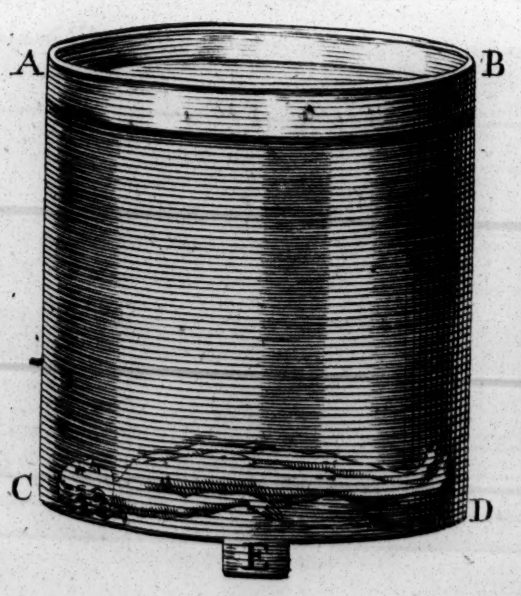
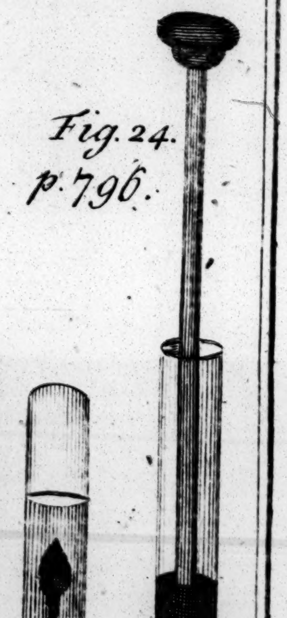


Fig. 24. p. 796.



J. Mynde sc.

## PARADOX X.

### *That the cauſe of the aſcenſion of water in ſiphons, and of its flowing through them, may be explicated without having a recourſe to nature's abhorrency of a vacuum.*

BOTH philoſophers and mathematicians having too generally confeſt themſelves reduced to fly to a *fuga vacui*, for an account of the cauſe of the running of water, and other liquors through ſiphons: and even thoſe moderns, that admit a vacuum, having (as far as I have met with) either left the phænomenon unexplicated, or endeavoured to explain it by diſputable notions: I think the curious much obliged to Monſieur *Paſcal*, for having ingeniouſly endeavoured to ſhew, that this difficult problem need not reduce us to have recourſe to a *fuga vacui*. And indeed his explication of the motion of water in ſiphons, ſeems to me ſo conſonant to hydroſtatical principles, that I think it not neceſſary to alter any thing in it. But as for the experiment he propounds to juſtify his ratiocination, I fear his readers will ſcarce be much invited to attempt it. For, beſides that it requires a great quantity of quickſilver, and a new kind of ſiphon, fifteen or twenty foot long; the veſſels of quickſilver muſt be placed ſix or ſeven yards under water, that is, at ſo great a depth, that I doubt whether men, that are not divers, will be able conveniently to obſerve the progreſs of the trial.

WHEREFORE we will ſubſtitute a way, which may be tried in a glaſs tube, not two foot deep, by the help of another peculiarly contrived glaſs, to be prepared by a ſkilful hand. Provide then a glaſs tube A B C D, of a good wideneſs, and half a yard or more in depth; provide alſo a ſiphon of two legs, FK, and KG, whereunto is joined (at the upper part of the ſiphon) a pipe E K, in ſuch manner, as that the cavity of the pipe communicates with the cavities of the ſiphon: ſo that if you ſhould pour in water at E, it would run out at F and G. To each of the two legs of this new ſiphon muſt be tied with a ſtring a pipe of glaſs, I and H, ſealed at one end, and open at the other; at which it admits a good part of the leg of the ſiphon to which it is faſtened, and which leg muſt reach a pretty way beneath the ſurface of the water, wherewith the ſaid pipe is to be almoſt filled. But as one of theſe legs is longer than the other, ſo the ſurface of the water in the ſuſpended pipe I, that is faſtened to the ſhorter leg K F, muſt be higher (that is, nearer to K or A B) than the ſurface of the water in the pipe H, ſuſpended from the longer leg K G; that (according to what is uſual in ſiphons) the water may run from a higher veſſel to a lower. Fig. XVIII.

ALL things being thus provided; and the pipe E K being held, or otherwiſe made faſt, that it may not be moved; you muſt gently pour oil of turpentine into the tube A B C D, (which, if you have not much oil, you may beforehand fill with water, till the liquor reach near the bottom of the ſuſpended pipes, as to the ſuperficies X Y) till it reach higher than the top of the ſiphon FKG, (whoſe orifice E you may, if you pleaſe, in the mean time cloſe with your finger, or otherwiſe, and afterwards unſtop) and then the oil preſſing upon the water, will make it aſcend into the legs of the ſiphon; and paſs through it, out of the uppermoſt veſſel J, into the lowermoſt H; and if the veſſel J were ſupplied with water, the courſe of the water through the ſiphon would continue longer, than here (by reaſon of the paucity of water) it can do.

Now in this experiment we manifeſtly ſee the water made to take its courſe through the legs of a ſiphon from a higher veſſel into a lower; and yet the top of the ſiphon being perforated at K, the air has free acceſs to each of the legs of it, through the hollow pipe E K, which communicates with them both. So that, in our caſe, (where there is no danger of a vacuum, though the water ſhould not run through the ſiphon) the fear of a vacuum cannot with any ſhew of reaſon be pretended to be the cauſe of its running. Wherefore we muſt ſeek out ſome other.

AND it will not be very difficult to find, that it is partly the preſſure of the oil, and partly the contrivance and ſituation of the veſſels; if we will but conſider the matter ſomewhat more attentively. For the oil, that reaches much higher than K, and conſequently than the legs of the ſiphon, preſſes upon the ſurface of the external water, in each of the ſuſpended pipes I and H. I ſay the external water, becauſe the oil floating upon the water, and the orifices of both the legs F and G, being immerſed under the water, the oil has no acceſs to the cavity of either of thoſe legs. Wherefore, ſince the oil gravitates upon the water without the legs, and not upon that within them, and ſince its height above the water is great enough to preſs up the water into the cavity of the legs of the ſiphon, and impel it as high as K, the water muſt by that preſſure be made to aſcend.

AND this raiſing of the water happening at firſt in both legs, (for the cauſe is in both the ſame) there will be a kind of conflict about K betwixt the two aſcending portions of water; and therefore we will now examine, which muſt prevail.

AND if we conſider, that the preſſure, ſuſtained by the two parcels of water in the ſuſpended pipes I and H, depends upon the height of the oil, that preſſes upon them reſpectively; it may ſeem (at the firſt view) that the water ſhould be driven out of the lower veſſel into the higher. For if we ſuppoſe that part of the ſhorter leg, that is unimmerſed under water, to be ſix inches long, and the unimmerſed part of the longer leg to be ſeven inches; becauſe the ſurface of the water in the veſſel I is an inch higher than that of the water in the veſſel H, it will follow, that there is a greater preſſure upon the water, whereinto the longer leg is dipped, by the weight of an inch of oil: ſo that that liquor being an inch higher upon the ſurface of the water in the pipe H, than upon that in the pipe I, it ſeems, that the water ought rather to be impelled from H towards K, than from I towards K.

BUT then we muſt conſider, that, though the deſcent of the water in the leg G be more reſiſted than that in the other leg, by as much preſſure as the weight of an inch of oil can amount to; yet being longer by an inch than the water in the leg F, it tends downwards more ſtrongly by the weight of an inch of water, by which length it exceeds the water in the oppoſite leg. So that an inch of water being *(cæteris paribus)* heavier than an inch of oil; the water in the longer leg, notwithſtanding the greater reſiſtance of the external oil, has a ſtronger endeavour downwards, than has the water in the ſhorter leg; though the deſcent of this be reſiſted but by a depth of oil leſs by an inch. So that all things computed, the motion muſt be made towards that way, where the endeavour is moſt forcible; and conſequently the courſe of the water muſt be from the upper veſſel, and the ſhorter leg into the longer leg, and ſo into the lower veſſel.

THE application of this to what happens in ſiphons is obvious enough. For, when once the water is brought to run through a ſiphon, the air (which is a fluid, and has ſome gravity, and has no acceſs into the cavity of the ſiphon) muſt neceſſarily gravitate upon the water, whereinto the legs of the ſiphon are dipped, and not upon that which is within the ſiphon: and conſequently, though the incumbent air have ſomewhat a greater height upon the water in the lower veſſel, than upon that in the upper; yet the gravitation it thereby exerciſes upon the former more than upon the latter, being very inconſiderable, the water in the longer leg much preponderating (by reaſon of its length) the water in the ſhorter leg, the efflux muſt be out of that leg, and not out of the other. And the preſſure of the external air being able to raiſe water (as we find by ſucking pumps) to a far greater height, than that of the ſhorter leg of the ſiphon; the efflux will continue, for the ſame reaſon, till the exhauſtion of the water, or ſome other circumſtance, alter the caſe. But, if the legs of the ſiphon ſhould exceed thirty four or thirty five foot of perpendicular altitude, the water would not flow through it; the preſſure of the external air being unable (as has been elſewhere declared) to raiſe water to ſuch a height. And if a hole being made at the top of a ſiphon, that hole ſhould be unſtopped, while the water is running, the courſe of it would preſently ceaſe. For, in that caſe, the air would gravitate upon the water, as well within as without the cavity of the ſiphon; and ſo the water in each leg would, by its own weight, fall back into the veſſel belonging to it.

In the Phyſico-mechanical Experiments.

BUT becauſe this laſt circumſtance, though clearly deducible from hydroſtatical principles and experiments, has not, that I know of, been verified by particular trials, I cauſed two ſiphons to be made, the one of tin, the other of glaſs; each of which had, at the upper part of the flexure, a ſmall round hole or ſocket, which I could ſtop and unſtop, at pleaſure, with the pulp of my finger. So that, when the water was running through the ſiphon, in caſe I removed my finger, the water would preſently fall, partly into one of the ſubjacent veſſels, and partly into the other. And if the legs of the ſiphon were ſo unequal in length, that the water in the one had a far greater height (or depth) than in the other; there ſeemed to be, when the liquor began to take its courſe through the ſiphon, ſome light preſſure from the external air upon the finger, wherewith I ſtopped the orifice of the ſocket made at the flexure.

AND on this occaſion I will add, what I have more than once tried; to ſhew, at how very minute a paſſage the preſſure of the external air may be communicated to bodies fitted to receive it. For, having for this purpoſe ſtopped the orifice of one of the above mentioned ſiphons, (inſtead of doing it with my finger) with a piece of oiled paper, carefully faſtned with cement to the ſides of the ſocket; I found, as I expected, that though hereby the ſiphon was ſo well cloſed, that the water ran freely through, yet, if I made a hole with the point of a needle, the air would at ſo very little an orifice inſinuate itſelf into the cavity of the ſiphon, and, thereby gravitating as well within as without, make the water in the legs to fall down into the veſſels. And though, if I held the point of the needle in the hole I made, and then cauſed one to ſuck at the longer leg; this ſmall ſtopple, without any other help from my hand, ſufficed to make the ſiphon fit for uſe: yet if I removed the needle, the air would (not without ſome noiſe) preſently get in at the hole, and put a final ſtop to the courſe of the water. Nor was I able to take out the needle, and put it in again ſo nimbly, but that the air found time to get into the ſiphon; and, till the hole were again ſtopped, rendered it uſeleſs, notwithſtanding that the water was by ſuction endeavoured to be ſet a running.

## PARADOX XI.

*That a ſolid body, as ponderous as any yet known, though near the top of the water, it will ſink by its own weight; yet if it be placed at a greater depth than that of twenty times its own thickneſs, it will not ſink, if its deſcent be not aſſiſted by the weigh of the incumbent water.*

THIS paradox having never been (that I know of) propoſed as yet by any, has ſeemed ſo little credible to thoſe to whom I have mentioned it, without excepting mathematicians themſelves) that I can ſcarce hope it ſhould be readily and generally received in this illuſtrious company, upon leſs clear teſtimony, than that of experience. And therefore, though (if I miſtake not) ſome part of this propoſition may be plauſibly deduced by the help of an inſtrument ingeniouſly thought upon by Monſieur *Paſcal*; yet I ſhall have recourſe to my own method for the making of it out, for theſe two reaſons: the one, that a great part of the paradox muſt be explicated, as well as proved, by the doctrine already ſettled in this paper; the other, that the experiment propoſed by Monſieur *Paſcal*, being to be done in a deep river, and requiring a tube twenty foot long, whoſe bottom muſt be fitted with a braſs cylinder, made with an exactneſs, ſcarce (if at all) to be hoped for from our workmen; if I ſhould build any thing on this ſo difficult an experiment, (which himſelf does not affirm to have ever been actually tried) I fear moſt men would rather reject the experiment as a chimerical thing, than receive for its ſake a doctrine that appears to them very extravagant.

Fig. XIX. LET us then, to employ in this caſe alſo the method we have hitherto made uſe of, fill a glaſs veſſel, A B C D, almoſt full of water; only, in regard that there is a great depth of water requiſite to ſome circumſtances of the experiment, this laſt muſt not be ſo ſhallow, as thoſe hitherto employed: but a deep cylinder or tube, ſealed at one end, whoſe depth muſt be at leaſt two or three foot, though its breadth need not be above two or three inches; and, to keep it upright, it may be placed in a ſocket of metal, or wood, of a ſize and weight convenient for ſuch a purpoſe. This glaſs being thus fitted in water, let us ſuppoſe E F to be a round and flat piece of ſolid braſs, having about an inch in diameter, and a fourth, or ſixth part of an inch in thickneſs. This cylinder, being immerſed under water, till it be juſt covered by the uppermoſt ſurface of that liquor, and being let go, muſt neceſſarily fall downwards in it; becauſe, if we ſuppoſe the imaginary ſuperficies G H to paſs along the circle F, which is the lower part of the braſs body, that metal being *in ſpecie* far heavier than water, the braſs, that leans upon the part F, muſt far more gravitate upon the ſaid part F, than the incumbent water does upon any other part of the ſuperficies G H; and, conſequently, the ſubjacent water at F will be thruſt out of place by the deſcending body. And becauſe that, in what part ſoever of the water, not exceeding nine times its thickneſs, meaſured from the top of the water A C, the ponderous body E F ſhall happen to be; there will be ſtill, by reaſon of the ſpecifick gravity of the metal, a greater preſſure upon that part of the imaginary ſuperficies, that paſſes along the bottom of the body, on which the part F ſhall happen to lean, than upon any other part of the ſame imaginary ſuperficies; the braſs body would ſtill deſcend by virtue of its own weight, though it were not aſſiſted by the weight of the water, that is over it. But let us ſuppoſe it to be placed under water on the deſignable plane J K; and let this plane, which (as all other imaginary planes) is, as well as the real ſurface of the water, to be conceived parallel to the horizon; and let the depth, or diſtance of this plane, from the uppermoſt ſurface of the water, be (ſomewhat) above nine times the thickneſs of the braſs body: I ſay, that, in this caſe, the body would not deſcend, if it were not preſſed downwards by the weight of the water it has over it. For, braſs being but about nine times * as heavy as water of an equal bulk to it, the body E F alone would preſs upon the part F, but as much as a cylinder of water would, which, having an equal baſis, were eight or nine times as high, as the braſs is thick. But now, all the other parts of the imaginary ſurfaces I K being preſſed upon by the incumbent water, which is as

high above them, as the newly mentioned cylinder of water would be; there is no reaſon, why the part F ſhould be depreſſed, rather than any other part of the ſuperficies J K: but becauſe it is true, which we formerly taught, namely, that water retains its gravity in water; and that too, though a body, heavier *in ſpecie* than it, be placed immediately under it; it will neceſſarily happen, that in what part ſoever the ſolid body be placed, provided it be every way environed with the water, it muſt, for the reaſon newly given, be made to move downwards, partly by its own weight, and partly by that of the incumbent water; and muſt continue to ſink, till it come to the bottom, or ſome other body, that hinders its farther deſcent.

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* The word, *about*, is added, becauſe indeed the author, as he elſewhere delivers, did, by exact ſcales, find braſs to weigh between eight and nine times as much as water; but judged it needleſs to his preſent argument, and inconvenient, to take notice of the fraction.

BUT in caſe the water above the ſolid body did not gravitate upon it, and thereby aſſiſt its deſcent; or in caſe, that the incumbent water were, by ſome artifice or other, ſo removed, that none of the lateral water (if I may ſo call it) could ſucceed in its place to lean upon the ſolid; then it will follow, from what we have newly ſhown, that the ſolid would be kept ſuſpended. And in caſe it were placed much deeper in the water, as over-againſt the point L, or M; then, if we conceive the incumbent water to be removed, or fenced off from it, the preſſure of the ſolid alone upon the part F, of the imaginary ſuperficies L M, being very much inferiour to that of the water upon the other parts of the ſame ſurface, the part F would be ſtrongly impelled upwards, by a force proportionate to the difference of thoſe two preſſures. And therefore, ſince I have found by trials, purpoſely made in ſcales marvellouſly exact, and with refined gold, (purer than, perhaps, any that was ever weighed in water) that gold, though much the ponderouſeſt of bodies yet known in the world, is not full twenty times as heavy, as water of the ſame bulk; I kept within compaſs, (as well as employed a round number, as they call it) when I ſaid, that no body (yet known) how ponderous ſoever, will ſubſide in water by its own weight alone, if it were ſo placed under water, that the depth of the water did above twenty times exceed the height of the body; not to mention here, that, though gold and water being weighed in the air, their proportion is above nineteen to one, yet, in the water, gold does, as other ſinking bodies, loſe as much of its weight, as that of an equal bulk of water amounts to.

I WAS ſaying juſt now, that, in caſe the brazen body were placed low enough beneath the ſurface of the water, and kept from being depreſſed by any incumbent water, it would be ſupported by the ſubjacent water. And this is that very thing, that I am now to ſhew by an experiment.

LET then the braſs body E F be the cover of a braſs valve, (as in the annexed figure) and let the valve be faſtened with ſome ſtrong and cloſe cement to a glaſs pipe, O P, (open at both ends) and of a competent length and wideneſs. For then the body E F, being the undermoſt part of the inſtrument, and not ſticking to any other part of it, will fall by its own weight, if it be not ſupported. Now then, tying a thread to a button Q, (that is wont to be made in the middle of the doors of braſs valves) you muſt, by pulling that ſtring ſtreight and upwards, make the body E F ſhut the orifice of the valve as cloſe as you can; (which is eaſily and preſently done.) Then, thruſting the valve under water, to the depth of a foot, or more, the cement and the ſides of the glaſs O P, (which reaches far above the top of the water X Y) will keep the water from coming to bear upon the upper part of the body E F; and conſequently, the imaginary ſurface V W, (that paſſes by the lower part of the ſaid body) will, where it is contiguous thereunto, be preſſed upon only by the proper weight of the body E F; but, in its other parts, by the much greater weight of the incumbent water. So that, though you let go the ſtring, (that held the body E F Fig. XX.

cloſe

cloſe to the reſt of the inſtrument) the ſaid body will not at all ſink, though there be nothing but water beneath it to ſupport it.

And to manifeſt, that it is only the preſſure of the water, of a competent depth, that keeps the ſolid ſuſpended; if you ſlowly lift up the inſtrument towards (X Y) the top of the water; you ſhall find, that, though for a while the parts of the valve will continue united, as they were before; yet, when once it is raiſed ſo near the ſurface, (as between the plane I K and X Y) that the ſingle weight of E F, upon the ſubjacent part of the imaginary plane, that paſſes by it, is greater than the preſſure of the incumbent water upon other parts of the ſame plane; that body, being no more ſupported as formerly, will fall down, and the water will get into the pipe, and aſcend therein to the level of the external water.

But if, when the valve is firſt thruſt under water, and before you let go the thread, that keeps its parts together, you thruſt it down to a good depth, as to the ſuperficies R S; then, though you ſhould hang a conſiderable weight, as L, to the valve E F, (as I am going to ſhew you a trial with a maſſy cylinder of ſtone broader than the valve, and of divers inches in length) the ſurpluſage of preſſure on the other parts of the plane V W, (now in R S) over and above what the weight of the body E F, and that of the cylindrical ſtone L to boot, can amount to, on that part of the ſurface, which is contiguous to the ſaid body E F, will be great enough to preſs ſo hard againſt the lower part of the valve, that its own weight, though aſſiſted with that of the ſtone, will not be able to disjoin them.

By which (to note that by the way) you may ſee, that though, when two flat and poliſhed marbles are joined together, we find it is impoſſible to ſever them without force; we need not have recourſe to a *fuga vacui* to explicate the cauſe of their coheſion, whilſt they are environed by the air, which is a fluid not devoid of gravity, and reaching above the marbles, no body knows how high.

And, to evince, that it is only ſuch a preſſure of the water, as I have been declaring, that cauſes the coheſion of the parts of the valve; if you gently lift it up towards the top of the water, you will quickly find the braſs body E F drawn down by the ſtone (L) that hangs at it; as you will perceive by the water's getting in between the parts of the valve, and aſcending into the pipe.

To which I ſhall only add, what you will quickly ſee, that, in perfect conformity to our doctrine, the preſſure of the body E F, upon the ſubjacent water, being very much increaſed by the weight of the ſtone, that hangs at it, the valve needs not, as before, be lifted up above the plane J K, to overcome the reſiſtance of the water, being now enabled to do it, before it is raiſed near ſo high.

## APPENDIX I.

*Containing an anſwer to ſeven objections, propoſed by a late learned writer, to evince, that the upper parts of water preſs not upon the lower.*

AFTER I had, this morning, made an end of reviewing the foregoing papers, there came into my hands ſome queſtions lately publiſhed, among other things, by a very recent writer of Hydroſtaticks. In one of which queſtions, the learned author ſtrongly defends the contrary to what has there been in ſome places proved, and divers places ſuppoſed.

The author of theſe Erotemata aſſerts, that, *in conſiſtent water, the upper parts do not gravitate, or preſs upon the lower.*

And therefore, I think it will be neither uſeleſs, nor improper, briefly to examine here the arguments he produces. Not uſeleſs; becauſe the opinion he aſſerts both is, and has long been, very generally received; and becauſe too is of ſo great importance, that many of the erroneous tenets and concluſions of thoſe, that (whether profeſſedly, or incidentally) treat of hydroſtatical matters, are built upon it. And not improper; becauſe our learned author ſeems to have done his reader the favour to ſum up into one page all the arguments for his opinions, that are diſperſedly to be found in his own, or other mens books. So that, in anſwering theſe, we may hope to do much towards a ſatisfactory deciſion of ſo important a controverſy. And, after what we have already delivered, our anſwers will be ſo ſeaſonable, that they will not need to be long; the things they are built on having been already made out in the reſpective places, whereto the reader is referred.

OUR author then maintains, that, in conſiſtent water, the ſuperiour do not actually preſs the inferiour parts, by the ſeven following arguments.

*Object.* 1. SAYS he, *Becauſe elſe the inferiour parts of the water would be more denſe than the ſuperiour, ſince they would be compreſſed and condenſed by the weight of them.*

*Anſ.* BUT, if the corpuſcles, whereof water conſiſts, be ſuppoſed to be perfectly ſolid and hard, the inferiour corpuſcles may be preſſed upon by the weight of the ſuperiour, without being compreſſed, or condenſed by them; as it would happen, if diamond-duſt were laid together in a tall heap: for, though the upper parts, being heavy and ſolid corpuſcles, cannot be denied to lean, and preſs upon the lower; yet theſe, by reaſon of their adamantine hardneſs, would not be thereby compreſſed. And it is poſſible too, that the corpuſcles of water, though not ſo perfectly hard, but that they may a little yield to an extreme force, be ſolid enough not to admit from ſuch a weight, as that of the incumbent water, (at leaſt in ſuch ſmall heights, as obſervations are wont to be made in) any compreſſion great enough to be ſenſible; as, beſides ſome trials I have formerly mentioned in another place, thoſe, made in the preſence of this illuſtrious company, ſeem ſufficiently to argue; *viz.* that water is not ſenſibly compreſſible by an ordinary force. And I find not, by thoſe, that make the objection, that they ever took pains to try, whether, in deep places of the ſea, the lower parts are not more condenſed than the upper; nor do I ſee any abſurdity, that would follow from admitting them to be ſo.

*Object.* 2. OUR author's ſecond argument is, *Becauſe divers feel not, under water, the weight of the water, that lies upon them.*

*Anſ.* BUT, for anſwer to this argument, I ſhall content myſelf to make a reference to the enſuing appendix, where this matter will be conſidered at large; and where, I hope, it will be made to appear, that the phænomenon may proceed, partly from the firm texture of the diver's body, and partly from the nature of that preſſure, which is exerciſed againſt bodies immerſed in fluids; which, in that caſe, (as to ſenſe) preſſes every where equally againſt all the parts of the body expoſed to their action.

*Object.* 3. THE third argument is, *That even the ſlighteſt herbs, growing at the bottom of the water, and ſhooting up in it to a good height, are not oppreſſed, or laid by the incumbent water.*

*Anſ.* BUT the anſwer to that is eaſy, out of the foregoing doctrine. For the plants, we ſpeak of, ſuſtain not the preſſure of the water above them by their own ſtrength, but by the help of the preſſure of water, that is beneath: which, being itſelf preſſed by the water, that is (though not perpendicularly over it) ſuperiour to it, preſſes them upwards ſo forcibly, that, if they were not by their roots, or otherwiſe, faſtened to the ground, they, being *in ſpecie* lighter than water, would be buoyed up to the top of the water, and made to float; as we often ſee that weeds do, which ſtorms, or other accidents, have torn from their native ſoil.

*Object.* 4. A FOURTH objection is this; *That a heavy body, tied to a ſtring, and let down under water, is ſupported, and drawn out with as much eaſe, as it would be, if it had no water incumbent on it; nay, with greater eaſe, becauſe heavy bodies weigh leſs in water, than out of it.*

*Anſ.* BUT an account of this is eaſy to be rendered out of our doctrine; for, though the water incumbent on the heavy body do really endeavour to make it ſink lower, yet that endeavour is rendered ineffectual to that purpoſe by the equal preſſure of the water upon all the other parts of the imaginary ſurface, that is contiguous to the bottom of the immerſed body. And that preſſure upon the other parts of that ſuppoſed plane being equal, not only to the preſſure of the pillar of water, but to that pillar, and to the weight of as much water, as the immerſed body fills the place of; it muſt needs follow, that not only the hand, that ſuſtains the body, ſhould not feel the weight of the incumbent water, but ſhould be able to lift up the body more eaſily in the water, than in the air. But, though the preſſure of the water incumbent on the ſtone cannot, for the reaſon aſſigned, be felt in the caſe propoſed; yet, if you remove that water, (as in the experiment brought for the proof of the laſt paradox) it will quickly appear by the preſſure againſt the lower part of the heavy body, and its inability to deſcend by its own weight, when it is any thing deep under water; it will, I ſay, quickly appear, by what will follow upon the abſence of the incumbent water, how great a preſſure it exerciſed upon the ſtone, whilſt it leaned on it.

*Object.* 5. THE fifth argument is propoſed in theſe words; *Becauſe a bucket full of water is lighter in the water, than out of it; nor does weigh more, when full within the water, than when empty out of it; nay, it weighs leſs, for the reaſon newly aſſigned,* (in the fourth objection) *therefore the water of the bucket, becauſe it is within water, does not gravitate, nor, conſequently, preſs downwards either the bucket, or the water under the bucket.* This is the grand and obvious experiment, upon which the ſchools, and the generality of writers have very confidently built this axiom, *That the elements do not gravitate in their proper place*; and particularly, that water weighs not (as they ſpeak) in its own element.

*Anſ.* WHAT they mean by *proper*, or natural *place*, I ſhall not ſtand to examine; nor to inquire, whether they can prove, that water, or any other ſublunary body poſſeſſes any place, but upon this account, that the cauſe of gravity, or ſome other movent, enables it to expel other contiguous bodies (that are leſs heavy, or leſs moved) out of the place they poſſeſſed before; and gives it an inceſſant tendency, or endeavour towards the lowermoſt parts of the earth.

BUT, as to the example propoſed, it is very eaſy to give an account of it; for, ſuppoſe A B C D to be a well, wherein, by the ſtring E F, the bucket is ſuſpended under water, and has its bottom contiguous to the imaginary plane I K: if now we ſuppoſe the bucket to conſiſt only of wood lighter than water, it will not only not preſs upon the hand, that holds the rope at E, but will be buoyed up, till the upper parts of the bucket be above the top of the water; becauſe the wood, whereof the bucket is made, being lighter *in ſpecie* than water, the preſſure of the water in the bucket G, and the reſt of the water incumbent on that, together with the weight of the bucket itſelf, muſt neceſſarily be unable to preſs the part H ſo ſtrongly, as the other parts of the imaginary plane I K are preſſed by the weight of the meer water incumbent on them. But if, as it is uſual, the bucket conſiſts partly of wood, partly of iron; the aggregate may often indeed be heavier than an equal bulk of water: but then the hand, that draws up the bucket by the rope F E, ought not, according to our doctrine, to feel the weight of all the bucket, much leſs that of the water contained in it. For though that aggregate of wood and iron, which we here call the bucket, be heavier than ſo much water; yet it tends not downwards with its whole weight, but only with that ſurpluſage of weight, whereby it exceeds as much water, as is equal to it in bulk; which ſurpluſage is not wont to be very conſiderable. And as for the water in the cavity G of the bucket, there is no reaſon, why it ſhould at all load the hand at E, though really the water, both in the bucket and over it, do tend downwards with their full weight; becauſe that the reſt of the water L I, and M K, do full as ſtrongly preſs upon the reſt of the imaginary ſuperficies I K, as the bucket and the incumbent water do upon the part H; and conſequently, the bottom of the bucket is every whit as ſtrongly preſſed upwards by the weight of the water upon all the other parts of the plane I K, as it tends downwards by virtue of the weight of the incumbent water, that is partly in the bucket, and partly above it; and ſo, theſe preſſures balancing one another, the hand, that draws the rope at E, has no more to lift up, than the ſurpluſage of weight, whereby the empty bucket exceeds the weight of as much water, as is equal in bulk (I ſay not to the bucket, as it is a hollow inſtrument, but) to the wood and iron, whereof the bucket conſiſts.

And becauſe this example of the lightneſs of filled buckets within the water has for ſo many ages gained credit to, if it have not been the only ground of, the aſſertion, that water weighs not in its own element, or in its proper place; I ſhall add (though I can ſcarce preſent it to ſuch a company as this without ſmiles) an experiment, that I made to convince thoſe, that were, through unſkilfulneſs or prejudice, indiſpoſed to admit the hydroſtatical account I have been giving of the phænomenon. I took then a round wooden box, which I ſubſtituted in the room of a bucket; and (having filled it with melted butter, into which, when it was congealed, ſome ſmall bits of lead were put, to make it a little heavier than ſo much water) I cauſed a ſmall ſtring of twined ſilk to paſs through two ſmall holes, made in the oppoſite parts of the upper edge of the box, and to be ſuſpended at one end of the beam of a pair of goldſmiths ſcales; and then putting it into a veſſel full of water, till it was let down there, to what depth I pleaſed, it appeared, that not only the leaſt endeavour of my hand would either ſupport it, or tranſport to and fro in the water, or draw it up to the top of it; and this, whether the box were made uſe of, or whether the butter and lead alone, without the box, were ſuſpended by the ſilken ſtring: but (to evince, that it was not the ſtrength of my hand, or the ſmallneſs of the immerſed body, that kept me from feeling any conſiderable reſiſtance) I caſt ſome grains into the ſcale, that hung at the other end of the above mentioned beam, and preſently raiſed the lead and butter to the ſurface of the water. So that, unleſs the ſchoolmen will ſay, that the butter and lead were in their own element, we muſt be allowed to think, that the eaſy ſuſtentation, and elevation of the box, did not proceed from hence, that thoſe bodies weighed not, becauſe they were in their natural place. And yet in this caſe, the effect is the ſame with that, which happens, when a bucket is drawing out of a well.

And, to manifeſt that it was the preſſure of the water againſt the lower part of the ſurface of our ſuſpended body, that made it ſo eaſy to be ſupported in the water, or raiſed to the top of it; I ſhall add, that though a few grains ſufficed to bring the upper ſurface of the butter to the top of the water, yet afterwards there was a conſiderable weight requiſite to raiſe more and more of its parts above the water's ſurface; and a conſiderabler yet, to lift the whole body quite out of the water. Which is very conſonant to our doctrine. For, ſuppoſe the bucket to be at the part N, half in and half out of the water: the hand or counterpoiſe, that ſupports it in that poſture, muſt have a far greater ſtrength than needed to ſuſtain it, when it was quite under water; becauſe that now the imaginary plain P Q, paſſing by the bottom of the bucket, has on its other parts but a little depth of water, as from L to P, or M to Q; and conſequently the bottom of the bucket, H, will ſcarce be preſſed upwards above half as ſtrongly as when the bucket was quite under water. And if it be raiſed to O, and conſequently quite out of the water; that liquor reaching no longer to the bottom of the bucket, can no longer contribute to its ſupportation; and therefore a weight not only equal, but ſomewhat ſuperiour to the full weight of the bucket, and all that it contains (being all ſuppoſed to be weighed in the air) will be neceſſary to lift it clear out of the water.

BUT to dwell longer on this ſubject cannot but be tedious to thoſe, that have been any thing attentive to the former diſcourſes. I proceed therefore to our author's ſixth argument, which is,

Object. 6. *That horſe-hairs, which are held to be of the ſame gravity with water, keep whatever place is given them in that liquor; nor are depreſſed by the weight of the ſuper-incumbent water.*

*Anſw.* Whether the matter of fact be ſtrictly and univerſally true, is ſcarce worth the examining, eſpecially ſince we find the difference in point of ſpecifick gravity, betwixt moſt horſe-hairs, and moſt waters, to be inconſiderable enough. But the phænomenon, ſuppoſing the truth of it, is very eaſily explicable, according to the doctrine above delivered. For ſuppoſing in the laſt ſcheme the body, R, to be bulk for bulk exactly equiponderant to water; it is plain there is no reaſon, why that body ſhould preſs the part S, of the imaginary ſuperficies I K, either more or leſs than that part S would be preſſed, if the body R being annihilated or removed, it were ſucceeded by a parcel of water of juſt the ſame bulk and weight. And conſequently, though all the water directly above the ſolid R do really lean upon that body, and endeavour to depreſs it; yet that endeavour being reſiſted by an equal and contrary endeavour, that proceeds (as we have been but too often fain to declare) from the preſſure exerciſed upon the other parts of the ſuperficies, I K, by the water incumbent on them; the body R will be neither depreſſed nor raiſed. And its caſe being the ſame in what part of the water ſoever it be placed, provided it be perfectly environed with that liquor; it muſt keep in the water (which in this whole diſcourſe we ſuppoſe to be homogeneous as to gravity) the place you pleaſe to give it.

AND (to add that, on this occaſion) though mathematicians have hitherto contented themſelves to prove, that in caſe a body could be found or provided, that were exactly equiponderant to water, it would retain any aſſignable place in it; yet the curioſity we had, to give an experimental proof of this truth, at length produced ſome glaſs-bubbles, which ſome gentlemen here preſent have not perhaps forgot, that were (by a dextrous hand we imployed about it) ſo exquiſitely poiſed, as, to the wonder of the beholders, to retain the places given them, ſometimes in the middle, ſometimes near the top, and ſometimes near the bottom of the water (though that were homogeneous) for a great while, till ſome change of conſiſtence or gravity in the water, or ſome of its parts, made the bubble riſe or fall.

THE application of this to what has been objected concerning horſe-hairs, being too eaſy to need to be inſiſted on, there remains to be diſpatched our author's ſeventh and laſt argument, which is this:

Object. 7. *That, otherwiſe, all the inferiour parts of the water would be in perpetual motion, and perpetually expelled by the ſuperiour.*

*Anſw.* BUT if, by the inferiour parts, he means ſuch portions, as are of any conſiderable bulk; the anſwer newly made to the laſt objection (where we ſhewed, that the body, R, would retain its place any where in the water, and conſequently near the bottom) will ſhew the invalidity of this objection. And unleſs we knew of what bigneſs and ſhape the corpuſcles of water are, it would perhaps be to little purpoſe to diſpute, how far it may be granted, or may be true in the particles, that water is made up of. Only this I ſhall add, that, whereas this learned author mentions it as an abſurdity, that the lower parts of water ſhould be in perpetual motion; and *Stevinus* himſelf, in the beginning of his hydroſtatical elements, ſeems to me to ſpeak ſomewhat inconſiderately of this matter; and though, as I lately ſaid, I allow ſuch ſenſible bodies, as thoſe, whoſe gravity in water writers are wont to diſpute of, to be capable of retaining their places in water, if they be *in ſpecie* equiponderant to it: yet I am ſo far from thinking it abſurd, that the inferiour corpuſcles of water ſhould be perpetually in motion, that I ſee not how otherwiſe they could conſtitute a fluid body, that reſtleſs motion of their parts being one of the generaleſt attributes of liquors; and being, in water, though not immediately to be ſeen, yet to be eaſily diſcovered by its effects: as, when ſalt, being caſt into water, the aqueous parts, that are contiguous to it, and conſequently near to the bottom, do ſoon carry up many of the ſaline ones to the very top of the water; where, after a while, they are wont to diſcloſe themſelves in little floating grains of a cubical ſhape.

BUT of this reſtleſs motion of the parts of liquors having profeſſedly treated elſewhere already; I ſhall add nothing at preſent, but rather take notice of what our author ſubjoins to the laſt of his arguments, (as the grand thing which they ſuppoſe) in theſe words: *Ratio porro, à priori, hujus ſententiæ videtur eſſe, quia res non dicitur gravitare, niſi quatenus habet infra ſe corpus levius ſe in ſpecie.* The erroneouſneſs of which conceit if I ſhould now go about ſolemnly to evince, I as well fear it would be tedious, as I hope it will be needleſs to thoſe, that have not forgot what may concern this ſubject in the former part of the now at length finiſhed diſcourſe; and eſpecially where I mention thoſe experiments, which ſhow, that neither a ſtone, nor gold itſelf, when placed deep under water, would ſink in it, if the ſuperiour water, that gravitates on it, did not contribute to its depreſſion.

In the hiſtory of fluidity and firmneſs.

## APPENDIX II.

*Concerning the reaſon, why divers, and others, who deſcend to the bottom of the ſea, are not oppreſſed by the weight of the incumbent water.*

AMONGST the difficulties, that belong to the Hydroſtaticks, there is one, which is ſo noble, and which does ſtill ſo much both exerciſe and poſe the wits of the curious, that perchance it will not be unacceptable, if to the former experiments we add, by way of appendix, one, that may conduce to the ſolving of this difficult problem; *viz.* why men, deep under water, feel no inconvenience by the preſſure of ſo great a weight of water as they are placed under?

THE common anſwer of philoſophers and other writers to this puzzling queſtion is, that the elements do not gravitate in their own proper places; and ſo, water in particular has no gravitation upon water, nor conſequently upon bodies every way ſurrounded with water. But that this ſolution is not to be admitted, may be eaſily gathered from our proofs of the firſt paradox, and from divers other particulars, applicable to the ſame purpoſe, that may be met with in the foregoing papers.

A FAMOUS writer, and, for aught I know, the recenteſt (except Monſieur *Paſcal*) that has treated of Hydroſtaticks, having rendered this reaſon of the phænomenon:

[*The ſuperiour parts of conſiſtent water* (as he ſpeaks) *preſs not the inferiour, unleſs beneath the inferiour there be a body lighter* in ſpecie *than water; and therefore, ſince a human body is heavier* in ſpecie *than water, it is not preſſed by the incumbent water, becauſe this does not endeavour to be beneath a human body*] He ſubjoins, contrary to his cuſtom, this confident epiphonema, *Quia aliam cauſam hujus rei aſſignant, errant, & alios decipiunt.*

BUT, by his favour, notwithſtanding this confidence, I ſhall not ſcruple to ſeek another reaſon of the phænomenon. For I have abundantly proved, that (contrary to the aſſertion on which his explication is built) the upper parts of water preſs againſt the lower, whether a body heavier or lighter *in ſpecie* than water be underneath the lower. And, the contrary of which being the πρῶτον ψεῦδος in this controverſy, perhaps the matter may be ſomewhat cleared, by mentioning here a diſtinction, which I ſometimes make uſe of. I conſider then a body may be ſaid to gravitate upon another body in two ſenſes. For ſometimes it actually ſinks into, or gets beneath the body, that was under it, as a ſinking ſtone gravitates upon water, and which I call prevalent, or ſucceſsful gravitation; and ſometimes it does not actually, at leaſt not viſibly deſcend, but only exerciſes its gravitation by preſſing againſt the ſubjacent body that hinders its deſcent: as when a woman carries a pail of water on her head, though the weight do not actually get nearer the center of the earth; yet it actually preſſes with its whole gravity upon the woman's head, and back, and other ſubjacent parts, that hinder its actual deſcent. And, according to this doctrine, I cannot admit our author's reaſoning, that becauſe a man's body is bulk for bulk heavier than water, therefore the water does not endeavour to place itſelf beneath it. For water, being a heavy body, derives from the cauſe of its gravity (whatever that be) an inceſſant endeavour towards the center of the earth; nor is there any reaſon, why its happening to be incumbent on a body heavier *in ſpecie* than itſelf, ſhould deſtroy that endeavour. And therefore, though it may be ſaid, that the water does not endeavour to place itſelf beneath a human body, becauſe indeed an inanimate liquor cannot properly be ſaid to act for this or any other end; yet the water being a heavy body, tends continually towards the lower part of the earth; and therefore will get beneath any body that is placed betwixt it and that, (without regard whether the inferiour body be heavier or lighter *in ſpecie* than itſelf) as far as the degree of its gravity will enable it; nor would it ever reſt, till it have reached the lowermoſt parts of the earth, if the greater ponderouſneſs of the earth, and other heavy bodies, did not hinder, (not its endeavour downwards, nor its preſſure upon ſubjacent bodies, but only) its actual deſcent.

THIS learned author himſelf tells us, (as well as *Stevinus*, and others, that have written of the Hydroſtaticks, unanimouſly teach) that if the bottom of a veſſel be parallel to the horizon, the weight of water, that reſts upon it, is equal to a pillar of water, having that bottom for its baſis, and for its height a perpendicular reaching thence to the uppermoſt ſurface of the water. Nor is it reaſonable to conceive, that there will be any difference in this preſſure of the incumbent water, whether the bottom be of deal, that will ſwim, or of box, that will ſink in water; or, to ſpeak more generally, whether it be of wood, *in ſpecie* lighter than water, or of copper, or ſome other metal, that is *in ſpecie* heavier than it. And ſince water, being not a ſolid body, but a fluid, conſiſts (as other fluids) of innumerable corpuſcles, that, though extremely minute, have their own ſizes and figures; and ſince the preſſure of water upon the bottom of a veſſel is proportionate to its perpendicular height over the bottom; it is manifeſt, that the upper corpuſcles preſs the bottom as well as the lower; which ſince they cannot do immediately, they muſt do by preſſing the intermediate

mediate ones. And I have already ſhown (diſcourſing one of the former paradoxes) that the ſuperiour parts of water do not only preſs thoſe, that are directly under them, but communicate a preſſure to thoſe, that are aſide of them, and at a diſtance from them.

AND if it be objected, that water endeavours to get beneath a bottom of glaſs-veſſels, or other bodies heavier *in ſpecie* than itſelf, becauſe under that bottom there is air, which is a lighter body *in ſpecie* than water: I ſay, that this is precarious; for the indiſputable gravity of the water is alone ſufficient to make it always tend downwards, (though it cannot always move downwards) whatever body be beneath it. And who can aſſure the makers of this objection, that there are not beneath even the bottom of rivers, or of the ſea, (where yet they ſay water is conſiſtent, and reſts as in its own place) vaſt ſpaces repleniſhed but with air, fumes, or fire, or ſome other body lighter than water? For, (not to mention, that the Carteſians take the earth we tread on, to be but a thin cruſt of the terreſtrial globe, whoſe inſide, as far as the center, is repleniſhed with a ſubtile fluid matter, like that whereof the ſun conſiſts) we know that in ſome places, as particularly at a famous coal-mine in *Scotland*, there are great cavities, that reach a good way under that ground, that ſerves there for a bottom to the ſea: ſo that, for aught theſe objectors know, even according to their own doctrine, the water, even in the ſea, may endeavour to get beneath a body heavier *in ſpecie* than itſelf.

BUT, for my part, I cannot but think, that, to imagine the water knows, whether or no there be air or ſome lighter body than itſelf beneath the body it leans on, and the ſuperiour parts do accordingly exerciſe or ſuſpend their preſſure upon the inferiour; is to forget that it is a heavy liquor, and an inanimate body.

ANOTHER ſolution there is of this hydroſtatical problem we have been diſcourſing of, which I met with in a printed letter of Monſieur *Des Cartes*, in theſe terms:

Second Tome, lettre 32.

Fig. XXII.

*Je ne me*, &c. *I remember not what reaſon it is, that* Stevinus *gives, why one feels not the weight of water, when one is under it: but the true one is, that there can no more of water gravitate upon the body, that is in it, or under it, than as much water as could deſcend in caſe that body left its place. Thus, for example, if there were a man in the barrel* B, *that ſhould with his body ſo ſtop the hole* A, *as to hinder the water's getting out, he would feel upon himſelf the weight of the whole cylinder of water* A B C, *of which I ſuppoſe the baſis to be equal to the hole* A: *foraſmuch as if he ſunk down through the hole, all the cylinder of water would deſcend too; but if he be a little higher, as about* B, *ſo that he does no longer hinder the water from running out at the hole* A, *he ought not to feel any weight of the water which is over him, betwixt* B *and* C; *becauſe if he ſhould deſcend toward* A, *that water would not deſcend with him, but contrariwiſe a part of the water, which is beneath him towards* A, *of equal bulk to his body would aſcend into its place: ſo that, inſtead of feeling the water to preſs him from the top downward, he ought to feel, that it buoys him upward from the bottom; which by experience we ſee.*

THUS far this ſubtile philoſopher; for whoſe ratiocinations though I am wont to have much reſpect, yet I muſt take the liberty to confeſs myſelf unſatisfied with this. For, having already ſufficiently proved, that the upper parts of water preſs the lower, and the bodies placed beneath them, whether ſuch bodies be lighter *in ſpecie* than water, or heavier; we have ſubverted the foundation, upon which Monſieur *Des Cartes*'s ingenious, though unſatisfactory, explication is built. And yet I ſhall add, *ex abundanti*, that ſuppoſing what he ſays, that, in caſe the ſolid B ſhould deſcend towards A, the incumbent water would not deſcend with it, but a part of the ſubjacent water, equal in bulk to the ſolid, would aſcend, and ſucceed in its room; yet that is but accidental, by reaſon of the ſtaunchneſs and fulneſs of the veſſel. And though, indeed, the ſuperiour water cannot actually deſcend upon the depreſſion of the ſolid at B, if at the ſame time, while that body deſcends, an equal bulk of water ſucceeds in its place; yet both the ſolid about C, and the water, that ſucceeds it, do, in their turns, hinder the deſcent of the ſuperiour water; which therefore muſt gravitate upon which ſoever of the two it be, that actually comes to be placed directly under it, if there be nothing before the diſplacing of the ſolid capable to take away the natural gravity, upon whoſe account the water over B and C does inceſſantly tend downwards. And though Monſieur *Des Cartes* does not ſo clearly expreſs himſelf, whether he ſuppoſes the hole at A to be ſtopped with ſome other body, when the ſolid is placed about B; yet, becauſe he is wont to ſpeak conſiſtently, I preſume he means, that, when the ſolid is removed to B, the hole at A is otherwiſe ſufficiently ſtopped; I ſay then, that the reaſon, why the ſolid, which, whilſt at A, ſuſtained a great preſſure from the incumbent water, feels not the weight of it, when placed at B, is not that, which Monſieur *Des Cartes* gives, but this; That the ſolid being environed with water, the ſubjacent water does (as we have often had occaſion to manifeſt) preſs it upwards full as ſtrongly (and ſomewhat more) as the weight of the incumbent water preſſes it downwards; ſo that a man's body, inſtead of ſinking, would be buoyed up, if, as it is a little heavier, it were a little lighter *in ſpecie* than water. Whereas, when the ſolid was that alone, which covered and ſtopped the hole, there was a manifeſt reaſon, why it ſhould be forcibly thruſt downwards by the weight of the incumbent water B C. For, in that caſe, there was no water underneath it at A, to ſupport the ſolid; and, by its preſſure, to enable it to reſiſt ſo great a weight.

AND this (to hint that upon the by) may, perchance, help us to gueſs at the reaſon of what geographers relate of the lake *Aſphaltites* in *Judea*, (in caſe the matter of fact be true) that this *Dead Sea* (as they alſo call it) will not ſuffer any living creature to ſink in it. For the body of a man (and, for aught we know, of other animals) is not much heavier *in ſpecie* than common freſh water. Now, if in this lake (that ſtands, where *Sodom* and *Gomorrah* did, before thoſe impious regions were deſtroyed by fire from heaven) we ſuppoſe, (which the nature of the ſoil, and the ſacred ſtory makes probable enough) that the water abounds with ſaline, or ſulphureous corpuſcles; (the former helping the latter to aſſociate with the water, as we ſee in ſoap conſiſting of ſalt and oil, and in chymical mixtures of alcalis and brimſtone diſſoluble in water), the liquor may have its gravity ſo augmented, as to become heavier *in ſpecie* than the body of an animal. For I have learned of a light ſwimmer, that he could hardly begin to dive in ſalt water, though he eaſily could in freſh. And it is not difficult to make a brine or lixivium (which are but ſolutions of ſalt in water) heavy enough to keep up an egg from ſinking. And not only barely by diſſolving a metalline body in a ſaline *menſtruum*, without otherwiſe thickening the liquor, I have brought ſolid pieces of amber itſelf to ſwim upon it; but I have tried, that certain ſaline ſolutions, which I elſewhere mention, nay, and a diſtilled liquor, (I uſed deflegmed oil of vitriol) without any thing diſſolved in it, would do the ſame thing, by reaſon of the numerous, though minute, corpuſcles of ſalt and ſulphur, that it abounds with.

THERE remains but one ſolution more of our hydroſtatical problem, that I think worth mentioning, and that is given by the learned *Stevinus* in theſe words:

*OMNI preſſu, quo corpus dolore afficitur, pars aliqua corporis luxatur; ſed iſto preſſu nulla corporis pars luxatur; iſto igitur preſſu corpus dolore nullo afficitur. Aſſumptio ſyllogiſmi manifeſta eſt; nam ſi pars aliqua, ut caro, ſanguis, humor, aut quodlibet denique membrum*

*membrum luxaretur, in alium locum concedat neceſſe eſſet: atqui locus ille non eſt extra corpus; cum aqua undiquaque æquali preſſu circumfuſa ſit (quod vero pars ima, per undecimam propoſitionem Hydroſtaticorum, paulo validius prematur ſuperiori, id hoc caſu nullius momenti eſt, quia tantula differentia partem nullum ſua ſede dimovere poteſt) neque item intra ipſum corpus concedit, cum iſtic corpore omnia oppleta ſint, unde ſingulæ partes ſingulis partibus æqualiter reſiſtunt, namque aqua undiquaque eadem ratione corpus totum circumſtat. Quare cum locus is nec intra, nec extra corpus ſit; abſurdum, imo impoſſibile fuerit, partem ullam ſuo loco emovere, ideoque nec corpus hic afficitur dolore.* *

THIS ſolution of *Stevinus* I eſteem preferable by far to thoſe, that are wont to be given of this difficult problem: but yet the phænomenon ſeems to me to have ſtill ſomewhat in it of ſtrange. It is true, that if the queſtion were only that, which ſome put, *viz.* Why the body of a diver, when it is near the bottom of the ſea, is not preſſed down by ſo vaſt a weight of water, as is incumbent on it? it might be rationally anſwered, That the weight of ſo much water, as leans upon the body, is not ſuſtained by the force of the body itſelf, but by that of the water, which is under it. For, by the experiments and explications, we have annexed to ſome of the foregoing paradoxes, it appears, that the ſubjacent water, by its preſſure upwards, is able, not only to ſupport the weight of the incumbent water, but ſo far to exceed it, that it would not only ſupport the immerſed body, and the incumbent water, but buoy up the body, if it were never ſo little lighter *in ſpecie* than water. And as for what *Stevinus* inſinuates, that, when the water preſſes the body every way, that preſſure is not felt, though it would be, in caſe it preſſed upon ſome parts, and not upon others; I am of the ſame opinion too: and, to prove it, ſhall not make uſe of the example he propoſes, in the words immediately following thoſe of his I juſt now recited; (for I doubt, that example is rather a ſuppoſition, than a tried thing) but by an experiment, which may be eaſily made, and has divers times been ſo, in our pneumatical engine. For, though the air be a heavy fluid, and though, whilſt it uniformly preſſes the whole ſuperficies of the body, we feel not the preſſure of it; and though, for this reaſon, you may lay the palm of your hand upon the open orifice of a ſmall braſs cylinder, applied to the engine inſtead of a receiver, without any hurt: yet when, by pumping, the air, that was before under the palm of your hand, is withdrawn, and conſequently can no longer help to ſupport your hand againſt the preſſure of the external and incumbent air, the external air will lean ſo heavy upon the back of your hand, that you will imagine, ſome ponderous weight is laid upon it. And I remember, by ſuch an experiment, I have not only had my hand put to much pain, but have had the back of it ſo bent downward, as if it were going to be broken.

BUT though ſuch conſiderations, as theſe, may much leſſen the difficulty of our phænomenon, whoſe cauſe is inquired into; yet ſtill it ſeems ſomewhat odd to me, that (ſince it is evident from the nature of the thing, and by *Stevinus*'s confeſſion, that there is a vaſt preſſure of water againſt every part of the body, whoſe endeavour tends inward) ſo exceedingly forcible a preſſure, (which thruſts, for inſtance, the muſcles of the arms and thighs againſt the bones, and ſkin and fleſh of the thorax againſt the ribs) ſhould not put the diver to any ſenſible pain; as I find not (by one that I examined) that it does; (though this man told me, he ſtayed a good while at the depth of betwixt eighty and one hundred foot under the ſea-water, which is heavier than freſh water:) for, that which *Stevinus*'s explication will only ſhow is, that there muſt be no manifeſt diſlocation of the greater parts of the body; whereas the bare compreſſion of two ſmall parts, one againſt another, is ſufficient to produce a ſenſe of pain.

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* *Stevinus Hydroſtat. lib.* 5. *pag.* 149.

*Sed exemplo clarius ita intelliges, eſto* A B C D *aqua, cujus fundum* D C, *in quo foramen* E *habeat epiſtomium ſibi inſertum, cui dorſo incumbat homo* F. *Quæ cum ita ſint, ab aquæ pondere ipſi inſidente nulla pars corporis luxari poterit cum aqua, ut dictum eſt, undiquaque æqualiter urgeat.* Fig. XXIII.

*Si vero ejus veritatem explorare libeat, eximito epiſtomium, tumque tergum nulla re fultum ſuſtinebitur, ut in locis cæteris, ideoque iſtic tanto preſſu afficietur, quantus tertio exemplo ſecundæ propoſitionis hujus demonſtratus eſt:* vid. *quantum efficit columna aquea, cujus baſis ſit foramen* E, *altitudo autem eadem quæ aquæ ipſi inſidentis. Quo exemplo propoſiti veritas manifeſte declaratur.*

BUT it ſeems, the texture of the bodies of animals is better able to reſiſt the preſſure of an every way ambient fluid, than, if we were not taught by experience, we ſhould imagine. And therefore, to ſatisfy thoſe, that (ſecluding the queſtion about the ſenſe of pain) think it an abundantly ſufficient argument, (to prove, that bodies immerſed under water, are not compreſſed by it) that divers are not oppreſſed, and even cruſhed by ſo vaſt a load of water, (amounting, by *Stevinus*'s computation, to many thouſands of pounds) as is incumbent on them: we will add, that though an experiment, propoſed by Monſieur *Paſcal* to this purpoſe, were ſuch, that at firſt ſight I ſaid, that it would not ſucceed, (and was not upon trial miſtaken in my conjecture;) yet it gave me the occaſion to make another, which will, I hope, fully make out the thing I deſigned it for.

THE ingenious Monſieur *Paſcal* would perſuade his readers, that if into a glaſs veſſel, with luke-warm water in it, you caſt a fly; and, by a rammer, forcibly preſs that water, you ſhall not be able to kill, or hurt the fly. Which, ſays he, will live as well, and walk up and down as lively, in lukewarm water, as in the air. But, upon trial with a ſtrong fly, the animal was (as we expected) preſently drowned, and ſo made moveleſs, by the lukewarm water.

WHEREFORE we ſubſtituted another experiment, that we knew would not only ſucceed, (as you will preſently ſee it will do) but teach us how great a preſſure the included animal muſt have been expoſed to. Fig. XXIV. We took then a ſomewhat ſlender cylindrical pipe of glaſs, ſealed at one end, and open at the other; and to this we fitted a rammer, which (by the help of ſome thongs of ſoft leather, that were carefully wound about it) did ſo exactly fill the pipe, that it could not eaſily be moved to and fro; and would ſuffer neither water, nor air, to get by betwixt it and the internal ſurface of the glaſs. We alſo provided ſome ſmall tadpoles (or *Gyrini*) about an inch long or leſs; which ſort of animals we made choice of before any other, partly becauſe they could, by reaſon of their ſmallneſs, ſwim freely to and fro in ſo little water as our pipe contained; and partly becauſe thoſe creatures, being as yet but in their infancy, were more tender, and conſequently far more expoſed to be injured by compreſſion, than other animals of the ſame bulk, but come to their full age and growth, would be; (as indeed ſuch young tadpoles are ſo ſoft and tender, that they ſeem, in compariſon to the bigger ſort of flies, to be but organized gelly.) One of theſe tadpoles being put into the water, and ſome inches of air being left in the pipe, for the uſe anon to be mentioned; the water and air, and conſequently the tadpole, were by the intruſion of the plug or rammer, with as great a force, as a man was able to employ, violently compreſſed; and yet, though the tadpole ſeemed to be compreſſed into a little leſs bulk than it was of before, it ſwam freely up and down the water, without forbearing ſometimes to aſcend to the very top, though the inſtrument were held perpendicular to the horizon. Nor did it clearly appear to us, that the little animal was injured by this compreſſion; and moſt manifeſt it is, he was not cruſhed to death, or ſenſibly hurt by it.

AND having repeated this experiment ſeveral times, and with tadpoles of differing ages; we may, I preſume, ſafely conclude, that the texture of animals is ſo ſtrong, that, though water be allowed to weigh upon water, yet a diver ought not to be oppreſſed

preſſed by it: ſince, whether or no water weighs in water, it is manifeſt, that in our experiment, the water, and conſequently the tadpole, was very forcibly by an external agent compreſſed betwixt the violently condenſed air, and the rammer. And, by the notice we took of the quantity of air before the compreſſion began, and that to which it was reduced by compreſſion; the moderateſt eſtimate we could make, was, that it was reduced into an eighth, or tenth part of its former ſpace; and ſo (according to what we have elſewhere proved) the preſſure, that was upon the air, (and conſequently upon the water, and the included tadpole) was as great, as that of a cylinder of water of above two hundred, if not three hundred foot high. And yet all this weight being unable to oppreſs, or ſo much as manifeſtly to hurt, the tender tadpole, (which a very ſmall weight would ſuffice to have cruſhed, if it preſſed only upon one part of it, and not upon the other) we may thence learn the truth of what we have been endeavouring to evince: That though water be allowed to preſs againſt water, and all immerſed bodies; yet a diver may very well remain unoppreſſed at a great depth under water, as long as the preſſure of it is uniform againſt all the parts expoſed thereunto.

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# A Confirmation of the former * ACCOUNT touching the late EARTHQUAKE near OXFORD, and the Concomitants thereof.

Firſt printed in the *Philoſophical Tranſactions*, N° xi. p. 179.
For *April* 2, 1666.

As to the earthquake, your curioſity about it makes me ſorry, that, though I think I was the firſt, that gave notice of it to ſeveral of the virtuoſi at *Oxford*; yet the account, that I can ſend you about it, is not ſo much of the thing itſelf, as of the changes of the air, that accompanied it. To inform you of which, I muſt relate to you, that riding one evening ſomewhat late, betwixt *Oxford* and a lodging I have at a place four miles diſtant from it, the weather having been for a pretty while froſty, I found the wind ſo very cold, that it reduced me to put on ſome defenſives againſt it; which I never ſince, nor, if I forget not, all the foregoing part of the winter was obliged to make uſe of. My unwillingneſs to ſtay long in ſo troubleſome a cold, which continued very piercing, till I had got half way homeward, did put me upon galloping at no very lazy rate; and yet, before I could get to my lodgings, I found the wind turned, and felt the rain falling: which, conſidering the ſhortneſs of the time, and that this accident was preceded by a ſettled froſt, was ſurpriſing to me, and induced me to mention it at my return, as one of the greateſt and ſuddeneſt alterations of air I had ever obſerved. And what changes I found, have been taken notice of in the gravity of the atmoſphere at the ſame time, by that accurate obſerver * Dr. *Wallis*, who then ſuſpected nothing of what followed, as, I ſuppoſe, he has ere this told you himſelf. Soon after, by my gueſs about an hour, there was a manifeſt trembling in the houſe, where I was, (which ſtands high in compariſon of *Oxford*) but it was not there ſo great, but that I, who chanced to have my thoughts buſied enough on other matters than the weather, ſhould not have taken notice of it as an earthquake, but have imputed it to ſome other cauſe, if one, that you know, whoſe hand is employed in this paper, and begins to be a diligent obſerver of natural things, had not advertiſed me of it, as being taken notice of by him, and the reſt of the people of the houſe. And ſoon after there happened a briſk ſtorm; whereupon I ſent to make inquiry at a place called *Brill*, which ſtanding upon a much higher ground, I ſuppoſed, might be more obnoxious to the effects of the earthquake, (of which, had I had any ſuſpicion of it, my having formerly been in one near the *Lacus Lemanus* would have made me the more obſervant) but the perſon I ſent to, being diſabled by ſickneſs to come over to me, (which he promiſed to do, as ſoon as he could) wrote me only a ticket, whoſe ſubſtance was, That the earthquake was there much more conſiderable, than where I lodged; and that, at a gentleman's houſe, whom he names, (the moſt noted perſon, it ſeems, of the neighbourhood) the houſe trembled very much, ſo as to make the ſtones manifeſtly to move to and fro in the parlour, to the great amazement and fright of all the family. The hill, whereon this *Brill* ſtands, I have obſerved to be very well ſtored with mineral ſubſtances of ſeveral kinds, and from thence I have been informed by others, that this earthquake reached a good many miles; but I have neither leiſure, nor inclination, to entertain you with uncertain reports of the extent and other circumſtances; eſpecially ſince a little further time and inquiry may enable me to give you a better warranted account.

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* See Num. x. of *Phil. Tranſactions*, p. 169—171; at the time of the printing whereof, this relation of Mr. *Boyle* was not yet come to hand.

## Some OBSERVATIONS and DIRECTIONS about The BAROMETER.

First printed in the *Philoſophical Tranſactions*, N° xi. p. 181.
For *April* 2, 1666.

As to the barometrical obſervations, (as for brevity's ſake I uſe to call them) though you † gueſſed aright, that, when I ſaw thoſe of the learned and inquiſitive Dr. *Beale*, I had not mine by me, (for I left them ſome years ſince in the hands of a virtuoſo, nor have I now the leiſure to look after thoſe papers) yet ſince, by the communication you have made publick, it is probable, that divers ingenious men will be invited to attempt the like obſervations, I ſhall (notwithſtanding my preſent haſte) mention to you ſome particulars, which, perhaps, will not appear unſeaſonable, that came into my mind upon the reading of what you have preſented the curious.

When I did, as you may remember, ſome years ago, publickly expreſs and deſire, that ſome inquiſitive men would make baroſcopical obſervations in ſeveral parts of *England* (if not in foreign countries ‖ alſo) and, to aſſiſt them to do ſo, preſented ſome of my friends with the neceſſary inſtruments: the declared reaſon of my deſiring this correſpondence was, (among other things) that, by comparing notes, the extent of the *atmoſpherical* changes, in point of *weight*, might be the better eſtimated. But not having hitherto received ſome account, that I hoped for, I ſhall now, without ſtaying for them, intimate thus much to you: That it will be very convenient, that the obſervers take notice, not only of the day, but, as near as they can, of the hour, wherein the height of the mercurial cylinder is obſerved. For I have often found, that within leſs than the compaſs of one day, or, perhaps, half a day, the altitude of it has ſo conſiderably varied, as to make it, in many caſes, difficult to conclude any thing certainly from obſervations, that agree but in the day.

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† See Num. ix. of the *Phil. Tranſact.* p. 159, the laſt paragraph.

‖ Some whereof have been ſince invited by the Publiſher, to give their concurrence herein.

IT will be requiſite alſo, that the obſervers give notice of the ſituation of the place, where their barometers ſtand, not only, becauſe it will aſſiſt men to judge, whether the inſtruments were duly perfected, but principally, becauſe that, though the baroſcope be good, (nay, becauſe it is ſo) the obſervations will much diſagree, even when the atmoſphere is in the ſame ſtate, as to weight, if one of the inſtruments ſtand in a conſiderably higher part of the country, than the other.

TO confirm both the foregoing admonitions, I muſt now inform you, that, having in theſe parts two lodgings, the one at *Oxford*, which, you know, ſtands in a bottom by the *Thames* ſide, and the other at a place four miles thence, ſeated upon a moderate hill; I found, by comparing two baroſcopes, that I made, the one at *Oxford*, the other at *Stanton St. John's*, that, though the former be very good, and have been noted for ſuch, during ſome years, and the latter was very carefully filled; yet by reaſon, that in the higher place, the incumbent part of the atmoſphere muſt be lighter than in the lower, there is almoſt always between two and three eighths of an inch difference betwixt them. And having ſometimes ordered my ſervants to take notice of the diſparity, and divers times carefully obſerved it myſelf, when I paſſed to and fro between *Oxford* and *Stanton*, I generally found, that the *Oxford* barometer, and the other, did, as it were, by common conſent, riſe and fall together ſo, as that in the former the mercury was uſually $\frac{3}{8}$ higher than in the latter.

WHICH obſervations may teach us, that the ſubterraneous ſteams, which aſcend into the air, or the other cauſes of the varying weight of the atmoſphere, do many times, and at leaſt in ſome places uniformly enough affect the air to a greater height than, till I had made this trial, I durſt conclude.

BUT, as moſt of the barometrical obſervations are ſubject to exception, ſo I found the formerly mentioned to be. For (to omit leſſer variations) riding one evening from *Oxford* to *Stanton*, and having, before I took horſe, looked on the baroſcope in the former of theſe two places, I was ſomewhat ſurpriſed to find at my coming to the latter, that in places no farther diſtant, and notwithſtanding the ſhortneſs of the time (which was but an hour and a half, if ſo much) the barometer at *Stanton* was ſhort of its uſual diſtance from the other, near a quarter of an inch, though, the weather being fair and calm, there appeared nothing of manifeſt change in the air, to which I could aſcribe ſo great a variation; and though alſo, ſince that time, the mercury in the two inſtruments hath, for the moſt part, proceeded to riſe and fall as before.

AND theſe being the only obſervations I have yet met with, wherein baroſcopes, at ſome diſtance of place, and difference of height, have been compared (though I cannot now ſend you the reflexions, I have elſewhere made upon them) as the opportunity I had to make them myſelf, rendered them not unpleaſant to me, ſo perhaps the novelty will keep them from being unwelcome to you. And I confeſs I have had ſome flying ſuſpicions, that the odd phænomena of the baroſcope, which have hitherto more poſed than inſtructed us, may in time, if a competent number of correſpondents do diligently proſecute the inquiries (eſpecially with baroſcopes, accommodated with Mr. *Hook*'s ingenious additions) make men ſome luciferous diſcoveries, that poſſibly we do not yet dream of.

I KNOW not, whether it will be worth while to add, that ſince I was obliged to leave *London*, I have been put upon ſo many leſſer removes, that I have not been able to make baroſcopical obſervations with ſuch a conſtancy as I have wiſhed; but, as far as I remember, the quickſilver has been for the moſt part ſo high, as to invite me to take notice of it; and to deſire you to do me the favour to inquire among your correſpondents whether they have obſerved the ſame thing*. For, if they have, this laſting (though not uninterrupted) altitude of the quickſilver happening, when the ſeaſons of the year have been extraordinary dry (ſo much as to become a grievance, and to dry up, as one of the late Gazettes informs us, ſome ſprings near *Weymouth*, that uſed to run conſtantly) it may be worth inquiry, whether theſe obſtinate droughts may not, by cleaving of the ground too deep, and making it alſo in ſome places more porous, and, as it were, ſpungy, give a more copious vent, than is uſual to ſubterraneal ſteams; which aſcending into the air, increaſe the gravity of it. The inducements I have to propoſe this inquiry, I muſt not now ſtay to mention. But perhaps, if the obſervation holds, it may prove not uſeleſs in reference to ſome diſeaſes.

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* This hath been inquired into, and is found, that ſeveral accurate and curious perſons (as the moſt noble Preſident of the Royal Society, the Lord Viſcount *Brounker*, Doctor *Beale*, Mr. *Hook*, &c.) have obſerved the ſame.

Perhaps it will be needleſs to put you in mind of directing thoſe virtuoſi, that may deſire your inſtructions about baroſcopes, to ſet down in their diaries not only the day of the month, and the hour of the day, when the mercury's height is taken, but (in a diſtinct column) the weather, eſpecially the winds, both as to the quarters, whence they blow (though that be not always ſo eaſy nor neceſſary) and as to the violence or remiſſneſs wherewith they blow. For, though it be more difficult, than one would think, to ſettle any general rule about the riſing and falling of the quickſilver; yet in theſe parts, one of thoſe, that ſeem to hold oftneſt, is †, that when the high winds blow, the mercury is the lower; and yet that itſelf does ſometimes fail: for, this very day (*March* 3.) though on that hill, where I am, the ſomewhat weſterly winds have been bluſtering enough, yet ever ſince morning the quickſilver has been riſing, and is now riſen near $\frac{3}{8}$ of an inch.

I had thoughts to add ſomething about another kind of baroſcope (but inferiour to that in uſe) whereof I have given ſome intimation in one of the preliminaries to the *Hiſtory of Cold*. But you have already too much of a letter, and my occaſions, *&c.*

The ſame noble obſerver further intimates, That, as for that cauſe of the height of the quickſilver in droughts, which by him is ſuſpected to be the elevation of ſteams from the cruſt or ſuperficial parts of the earth, which by little and little may add to the weight of the atmoſphere, being not, as in other ſeaſons, carried down from time to time by the falling rain, it agrees not ill with what he has had ſince occaſion to obſerve. For, whereas about *March* 12th, at *Oxford*, the quickſilver was higher than, for aught he knew, had been yet obſerved in *England*, *viz.* above $\frac{1}{16}$ above thirty inches, upon the firſt conſiderable ſhowers, that have interrupted our long drought, as he affirms, he foretold divers hours before, that the quickſilver would be very low, (a bluſtering wind concurring with the rain) ſo he found it at *Stanton* to fall $\frac{3}{8}$ beneath 29 inches ‡.

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† See Num. ix. *Phil. Tranſact.* p. 157.—5, 8, 9. where the word *generally* ſignifies no more than *for the moſt part.*

‡ Dr. *Beale* concurs with this obſervation, when he ſaith, in a late letter of *March* 19, to his correſpondent in *London: By change of weather and wind, the mercury is ſunk more than an inch, ſince I wrote to you on* Monday *laſt*, March 12. *This laſt night, by rain and ſouth-wind, it is ſunk half an inch.*

## END OF THE SECOND VOLUME.

MVSEVM
BRITAN
NICVM